Concept of an Information and Decision Support System applied to the EU Interreg IIIB funded project: nature-oriented flood damage prevention

Master Thesis prepared at the Section of Engineering Hydrology and Water Resources Management
TU Darmstadt, Germany
August 2005

prepared by Sara Benetti, Politecnico of Torino, Italy

TECHNISCHE UNIVERSITÄT DARMSTADT

TECHNISCHE UNIVERSITÄT DARMSTADT

Institut für Wasserbau und Wasserwirtschaft
Fachgebiet für Ingenieurhydrologie und Wasserbewirtschaftung

THESIS

Concept of an Information and Decision Support System applied to the EU Interreg IIIB funded project: nature-oriented flood damage prevention

nofdp

Betreuer:
Prof. Dr. Ing. Manfred Ostrowski
Dipl. Ing. Axel Winterscheid
Prof. Dr. Ing. Marcello Schiara

Darmstadt, 28 September 2005

Student:
Sara E. Benetti

Preface

This thesis is the result of my stay at the Technische Universität Darmstadt (from October 2004 to July 2005) in the context of an Erasmus exchange programme between TU Darmstadt and Politecnico of Torino.
This thesis represents in Italy the final project for graduating students in environmental engineering.

I would like to thank all the people that gave me help and sustain in the development of this work. First of all I want to thank my tutors Dipl. Ing. Axel Winterscheid, Prof. Dr. Ing. Manfred Ostrowski at the Technische Universität Darmstadt and Prof. Dr. Ing. Marcello Schiara at the Politecnico of Torino.
Secondly I would like to thank all members of the nofdp group for giving me the possibilities to have access to all the information regarding nofdp project and to directly take part in some working meetings, because without them this work looses much of its worth.
I also want to thank Ing. Matthias Sottong for the interview with water board Mümling, which provides the conclusion to this work.
Finally I would like to thank Vasco Mantellini, André Peigné, Isabel Villar, Ethne Miller and Roberta Varda for the fundamental moral and logistic help which they provided me in the course of this exciting experience.

Dedicato ai miei genitori

Contents

Index of tables

Index of figures

1 Introduction

This thesis is the result of my stay as Erasmus exchange student at the Technische Universität Darmstadt (from October 2004 to July 2005).
This Thesis was developed in the context of nofdp (nature-oriented flood damage prevention) project; a brief description of the project is provided in section 1.2, but first of all a synthesis of purposes and objectives of the research is given in section 1.1.
Finally section 1.3 provides a definition and a context to the problem faced by this thesis introducing the theme of sustainable, integrated water management and in particular what considering nature-oriented flood damage prevention alternatives could signify.

1.1 Purpose and objectives of the Thesis

This final thesis was developed in the context of the nofdp project, whose main objective is the development of an IDSS (Information and Decision Support System), further information about DSS (Decision Support Systems) can be found in chapter 2.
The ultimate target of the thesis is to provide a conceptual scheme to the nofdp IDSS, that is to say the purpose of the research lies on the definition of the most important IDSS functionalities (for the definition of functionality, refer to section 2.3) related to nofdp project.
In order to achieve this objective, the main tasks of this work are:

- Selection of the most important reflections on DSS
- Definition of potential users for nofdp IDSS
- Definition of nofdp IDSS most important functionalities, requirements and objectives
- Presentation of the defined IDSS concept for the Water Board Mümling.

The first task is developed in chapter two and it consists of a literature research regarding Decision Support Systems; the result of this first step is an overview about DSS and in particular, after a description of what these systems represent, the reader can find some final conclusions about benefits, limitations, difficulties developing DSS and above all the reason why a DSS seems to be a good solution for nofdp project objectives.

The second and the third tasks are developed in chapter three; In this chapter an analysis of many relevant documents linked with the theme of nature-oriented flood damage prevention alternatives is carried out, in order to gather information and make relative conclusions on who the potential users of nofdp IDSS are and above all to give a profile of the most important functionalities for the system.
This second part of the work differs from the first one, in that the report takes the connotation of an "experience report", that is to say most of the outcome described at the end of the analysis are the consequence of project developments, which I personally took part in thanks to the high degree of participation that the project partners gave me.
For this reason parallel to literature considerations most of the reflections are the result of what I have personally experienced in the course of this year by nofdp project.
The final task of the work is developed in chapter four, where the reader can find the presentation of the developed conceptual IDSS scheme to the nofdp investment project "Retention Area-Zell-Water Board Mümling". In particular an analysis of the interview with Ing. Matthias Sottong working at water board Mümling is carried out; this interview gives the conclusion to the work and it is particularly worthwhile in order to test the conceptual scheme with a potential user of the system.
Finally in chapter five the reader can find all the most important conclusions about this work and above all some open questions and recommendations regarding future developments of nofdp IDSS.

1.2 nofdp project description

nofdp (nature-oriented flood damage prevention) is an INTERREG IIIB NWE[1] funded project launched in spring 2004; it's a four-year transnational project with partners[2] from the Netherlands and Germany and its target is to introduce a new integrated view in the field of flood damage prevention.
We can find a definition of the overall objective of nofdp project in the project overview by Winterscheid, A. e al. (2004): "The overall objective of the nofdp project is to develop

[1] The North West Europe Programme belongs to strand B of the European Community Initiative INTERREG III which supports transnational co-operation in the field of spatial development between national, regional and local authorities and a wide range of non-governmental organisations.
[2] Lead Partner: Hessian Ministry for the Environment, Rural Development and Consumer Protection
Project Coordination: Darmstadt University of Technology
Partners: German Federal Institute of Hydrology, Provincie Noord-Brabant, Waterboard Brabantse Delta, Waterboard Aa en Maas, Waterboard de Dommel, Waterboard Mümling.

an information and knowledge base as well as decision support tools to assist Member States of the NWE-Region in making optimum decisions for riverine planning considering ecological improvement for river corridors with a high degree of public participation, spatial development and flood damage prevention”.

The integrated approach introduced by the project consists of considering the river system like the result of three overlapping layers: water level, ecological level and human level.

The first layer is represented by the water and soil system itself, the second by the human infrastructure including land use and the third one integrates the status of ecosystematic functionality of the whole river ecosystem (Winterscheid, A. e al., 2004).

Reason for this new overlapping layers approach in planning flood damage prevention measures is the increasing interest on topics like integrated water management (a discussion on these topics is provided in section 1.3), interest also shown in the European Water Framework Directive (2000/60/EC).

A new approach planning flood damage prevention measures is required; it has to consider not only pure technical aspects, but the integration of other important elements like ecology and spatial planning.

The project tries to achieve this ambitious target by providing its customers with three products: an Information and Decision Support System, a Knowledge Base and a printed handbook containing guidelines.

The knowledge base and the printed handbook will contain information about legislation, spatial planning, best practice examples and generally all the most relevant knowledge about nature oriented flood damage prevention alternatives.

The IDSS will be the main product; it will be able to forecast consequences of planning alternatives and it will be helpful to communicate them; particular attention is given to the development of an innovative eco-hydrological model, that is to say a model capable of forecasting the ecological response on altering hydrological regimes (see the discussion on feasibility regarding models in chapter 3).

Moreover the integration of four real investment projects will provide an important added value in terms of knowledge, models, data and participation.

Between these four investment projects three are located in the Netherlands and one in Germany and they all include from small to medium-size rivers.

The investment projects involved in the nofdp project are:

- The Steenbergsche Vliet / Water board Brabantse Delta (The Netherlands)
- Dynamic River Basin, River de Aa / Water board Aa en Maas (The Netherlands)
- Tongelreep project / Water board de Dommel (The Netherlands)
- Retention area Zell / Water board Mümling (Germany)

The first project is located in the Netherlands (Province of Noord-Brabant); the *Steenbergsche Vliet* river is part of the Mark and Vliet river system, which is defined as a so called Ecological Connection Zone between national and international natural connection areas. The water board Brabantse Delta, responsible for that area, has developed a master plan for the enhancement and management of the river system, respecting nature development and flood damage prevention particularly around the city of Breda.

In particular the higher discharge of Rhine and Maas in this zone, increasing flood protection standard (recurrence of 1/100 years for urban areas) and climate changes give the urgency for extra attention.

The foreseen measures along the Steenbergsche Vliet river are the construction of several types of natural riverbanks (with reeds, groves, floodplain grasslands and marsh vegetation for a total restored area of 62 ha, where the minimum target for nofdp is 17,5 ha) and the development of water storage, swamplands, ecological embarkments, riparian forest and recreational facilities (for a total length of 15 km); moreover the change of land use from agriculture to nature will give an important contribution in decreasing the damage of floodings.

The second project, developed by the water board Aa en Maas, is also located in the Netherlands (Province of Noord-Brabant), along the river *De Aa*.

Here the strong action of human activities brought to the fact that many of the natural meanders were straightened and natural banks were cancelled. In addition water was pumped out over a period of 80 days a year for agricultural scopes.

Today a planned new diversion of a shipping channel will cause further problems, because the channel will cross river De Aa by means of siphon.

One of the alternatives was to strengthen the existing dykes along the river, but the restoration of the natural resilience of the river system by removing these dykes and giving access for the river to its natural floodplains was preferred.

So the most important planned measures for this project are the restoration of the meanders and other morphologic features (for a length of 7 km), the creation of wetland zone of inundated land (100 ha for annually inundated land, 200 ha for inundated land once every 10 years, 400 ha for inundated land once every 100 years), the protection of high valuable areas with small dykes and drainages; in particular nofdp project will include the first 1,5 km of this project called “Dynamic River Basin De Aa”.

Once again a fundamental aspect of the project is the change of land use from agriculture to retention area, with the implementation of so called “Green-Blue Services” (for further explanations refer to section 1.3).

The third Dutch investment project (Province of Noord-Brabant) is located in the catchment area of the *Tongelreep* (which is part of the Dommel catchment), circa 10 km south of the city of Eindhoven.

Here the water board de Dommel, with other participants has developed an action programme in order to give a sustainable environment to the main part of Tongelreep catchment area.

The programme will be split up into three phases and nofdp project will include the first one.

In particular the Tongelreep river suffers from peak discharges and at the same time from dryness periods; moreover downstream the project area, due to river canalisation and drainage of land, the cities of Eindhoven and ‘s Hertogenbosch are subject to damages caused by floods at a frequency of once every 10 years.

For these reasons some old and ecologically valuable fish ponds, today no more used for fish breeding, will be transformed into retention basins (circa 10 ha of them); the meanders will be restored (along 5 km, using 15 ha of the fish ponds); dryness problems will be improved by shoaling the bed line of the Tongelreep and dividing the available water between the river and fish basins; finally the quality of the water will be improved by settling basins with helophyte filters.

The last project is located in Germany (Federal State of Hessen), in the river *Mümling* catchment area, which is part of river Main catchment area.

In 1993 and 1995 two severe floods caused a lot of damage to the infrastructures along the river, for this reason the water board Mümling started (in 1999) a pilot project aimed at improving flood damage prevention; as a result the activation of a retention area upstream to the village of Zell was decided. The artificial dam will store 200.000 m^3.

Another time a multi-sectoral approach is requested, because some of the inundated land (1,5 ha) is owned by farmers, for this reason a kind of compensation payment will be discussed with them.

Moreover the Federal State of Hessen has started the development of a GIS-based cadastre (RKH-Retentionkataster Hessen) containing locations of existing and potential retention areas of about 350 Hessian rivers; this cadastre represents a very interesting kind of database and "collection" of input possibilities for the IDSS, because with the integration of such a system, the IDSS will be able to make calculations not only for the projected dam, but also for many other potential natural retention areas along the river Mümling or other rivers of the Rhine catchment area.

Further information about common objectives of these four investment projects are provided in section 1.3.

It's important to underline that in a first phase the investment projects will provide the development group working at the IDSS with knowledge, models and data, but in a second phase the investment group will be supported by the developed software tools and knowledge.

Moreover two studies covering catchment areas between Belgium and The Netherlands (transboundary catchment areas of the river Mark and the river Dommel) give to the nofdp project transnational added value.

More information can be downloaded on nofdp web site: www.nofdp.net.

Particular attention is to devolve to some current actions of the project: the International Workshop organized in October 2005 (´s-Hertogenbosch, The Netherlands) and the Questionnaire on Ecology and Flood Management;

The International Workshop will represent a milestone in the same direction of research of this work; a great number of potential users of the system will be invited in order to involve them in the IDSS development and try to make the point on IDSS user important requirements.

At the same time in the month of April a questionnaire was sent to four countries: Germany, Netherlands, England and France; it represents an important action in order to gather new information on ecology and flood management in the North West territory (four versions in German, English, French and Dutch are available on nofdp web site).

1.3 nofdp problem context definition

According to Marakas (1999) the first step in DSS development is the formal identification and recognition of a problem context requiring decision support; for that reason, before developing any theory about the nofdp IDSS, this section tries to give a definition to what nature oriented flood damage prevention could signify.

One can easily understand that the expression: "nature-oriented flood damage prevention" refers not only to the name of the project, but it also introduces a new approach in the field of flood damage prevention.

In particular during the last decades some severe floods have brought water managers, policy makers and water authorities to rethink about the past sectoral approach in planning flood prevention strategies and try to make them more sustainable. Concrete actions in order to prevent flood events are requested, but always remembering that floods are also natural part of the hydrological cycle (IKSR 1995).

This new vision can be summarized by the concept that nowadays flood prevention can no more depend only on technical measures, but it also has to consider the integration of new important elements such as ecology and human issues.

Also the EU WFD (European Water Framework Directive (2000/60/EC)) underlines this new concept proposing itself like a basis for dialogue and development of strategies towards a further integration of policy areas.

Now it is necessary to understand how nofdp project tries to bring about this general concept, because as we will see in chapter 2 one critical factor in developing DSS is the lack of clear purposes in the definition of the problem context; for that reason in the initial phase of such a project it is fundamental to decide which problems should be addressed by the DSS (De Kok and Wind 2003).

In the project overview (Winterscheid et al. 2004) a first specification of how nofdp project introduces its objectives in this new context can be found: "Within nofdp a three layers approach is introduced. The first layer represents the water and the soil system itself, the second the human infrastructure including land use and the third layer integrates the status of ecosystematic functionality of the whole river ecosystem. This system is embedded into a political framework of decision making";

A natural conclusion of such a conception is that an integrated assessment of the future status of these three layers is requested. Figure 1.1 shows a schematic representation of the three layers approach introduced by nofdp project.

So the most important subjects of concern that the reader has to keep in mind during the entire development of the thesis are: the water system, the human system (including infrastructures and the land use) and the river ecosystem; they have to cooperate overlapping their sectoral information, because taking up the cause of holistic water protection as defined by sustainability, means taking into account ecological, economic and social aspects simultaneously and at an equal level (ICPR 2001).

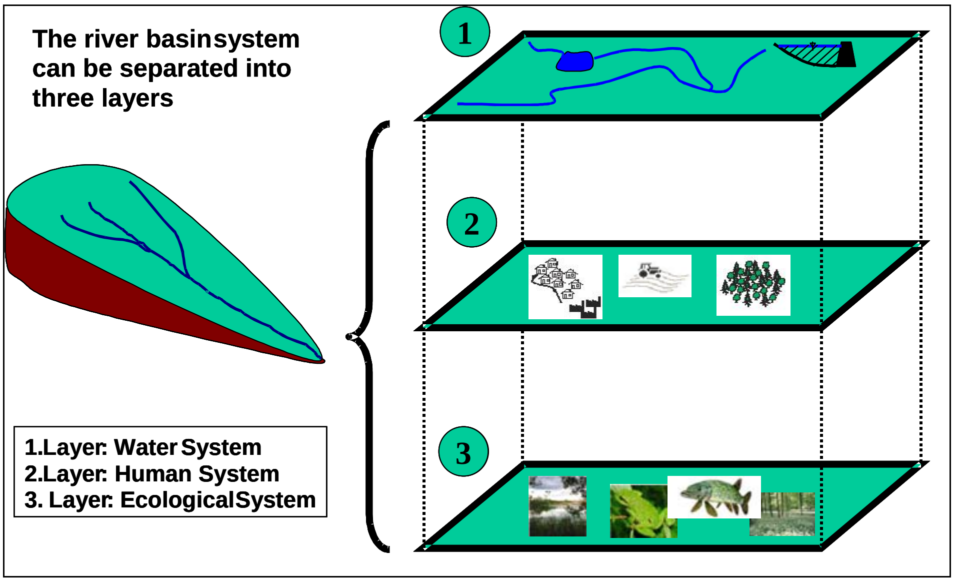


Figure 1.1: The three layers approach introduced by the nofdp project (Winterscheid et al. 2004).

Unfortunately this three layers approach still expresses a very general and theoretical concept, but it can be specified by analysing what are some of the most important common characteristics linking the four nofdp investment projects; these four examples should, according to the opinion of the project partners, give a concrete application of what implementing nofdp alternatives signifies.

In section 1.2 the reader has already found a brief description of these four projects; now some common characteristics and goals, which link these four case studies will be summarized and extracted; the result of such an analysis will give us a clearer picture of the problem context faced by nofdp project.

The First common characteristic is the fact that all the projects cover small to medium size river basins; this is quite an important constraint if we consider that in such cases requirements regarding for example the navigability are not to be considered.

In any case some important morphological differences arise between the first three projects and the last one; The river basins located in the Netherlands have a typical plain topography, while the Mümling catchment area is a typical Rhine sub-catchment with hilly topography (up to 500 m asl); as a consequence the Mümling investment project is directly located where high peak flows are generated and little natural retention volume is available; on the contrary in the three Dutch investment projects more possibilities regarding natural retention volume are available and flood damage prevention is realised by means of little dykes and activation of natural floodplains.

A list of important common goals for the four projects is provided in table 1.1.

Table 1.1: Common goals of nofdp investment projects

nofdp investment projects common goals
Flood damage prevention as primary target (natural retention volume as first choice)
Multifunctional land use
Protection and conservation of areas with high cultural and natural value
Enhancement of the ecological functionality of the river system
Creation of recreation possibilities
Cooperation during the planning process with the stakeholders group (communities, nature organisations, farmers, etc.)
Involvement of planning authorities
Improvement of transnational cooperation
Exchange of data, models and knowledge

The first common goal refers to *flood damage prevention* and this objective is of primary importance in all the projects; reasons are some severe floods, with urban areas suffering from flood events, higher flood protection targets or simply raising water levels due to climate changes. In addition the increasing population density of flood natural inundation areas and at the same time the intensive cutting off of these areas (most of the time for agricultural scopes) aggravate the situation.

Retention volume for flood prevention is needed, but what these projects show is the preference towards natural retention volume (e.g. activation of natural floodplains), in contrast to pure technical measures like raising existing dykes (they have to be considered as the last possibility (IKSR 1995)).

Best example explaining this concept, is the project on the river De Aa; the dykes will be removed and more room will be given to the river by restoring its old meanders and giving access to its natural floodplains;

Emergent key concept is to consider the restoration and conservation of wetlands and floodplains as natural controllers of flood waters, using natural water retention and storage capacities of both upland wetland and lowland floodplain areas; in this manner floods will be better managed and the EU WFD key objective of securing good ecological status for waters will be achieved (Lammel 2002).

The focus is pointed on the resilience more than on the resistance of the system, in other words, instead of trying to control or restrict natural processes by technical measures, it should be sought to create a flexible system, which can deal with unpredictable events and be adapted to cope with future developments (Zuiderent 2003).

It follows that the restoration of natural retention areas preventing floods should be the first alternative to consider, but sometimes such kind of measures are not enough and the integration of more technical measures have to be considered (e.g. small dykes); the German investment project on the Mümling river shows us how a lack of a sufficient natural retention volume leads to a more technical approach.

Closely linked to the need of natural retention volume for flood prevention, there is the objective of developing *multifunctional land use*, where multifunctional refers to the concept that the area reserved to the river as inundation land, can be used also for other purposes (e.g. agriculture, recreation, etc.).

In particular main conflicts derive from farmland, for this reason one of the most innovative aspect of nofdp investment projects, is the implementation of “Green-Blue Services”. For example they are applied in Steenbergsche Vliet and Dynamic River Basin, River Aa projects and they represent a new kind of compensation payment. The idea is that of providing farmers with an advanced form of compensation (annual payments, permissions of extensive use of parts of flooded areas, lenience towards current restrictions) in case they accept to deliver some services such as temporary storage of water, not using pesticides and fertiliser, not using some crops that damage the landscape, removing debris after floods, changing the crop cycle according to changing water levels and so on; this new action will also increase the speed of project implementation, because procedures for changing the spatial planning will take too long time. Also in the project on the river Mümling, the farmland will not be purchased, but a form of compensation payment will be discussed with farmers.

Multifunctional is also the approach carried out in the Tongelreep project, because part of some old fish basins (with a high natural value) will be used for water storage and remeandering; so this time the cooperative functionalities are the ecological, the flood prevention and the recreational one (the area will be open to the public).

The next two nofdp investment projects common goals are closely linked; first of all there is the *protection of existing area with high ecological and cultural value*, because the existing valuable zones must be protected, before to improve them; the Steenbergsche

Vliet is a good example, because it is part of an ecological connection zone, with an unique landscape and the presence of some historical monuments;

In particular as stated in the European Habitats Directive (92/43/EEC), the preservation, the protection and improvement of the quality of the environment, also include the conservation of natural habits and of wild fauna and flora; for this reason the fish ponds in the Tongelreep project with its old flora and fauna possesses a significant natural value for its safeguard. Such areas have to be protected also by means of more technical measures (e.g. small dykes on the river De Aa).

The Protection of these areas is not enough and the second linked goal is the *Enhancement of the ecological functionality of the river system*; this concept refers to the fact that the projected measures should obviously don't cause any further significant damage to the ecological functionality of the river system, but they have to go further trying to improve it; also in the EU WFD it can be found that the member States have to protect, restore, but also enhance all bodies of surface water with the aim of achieving good surface water status.

Once again the preference of nofdp measures towards natural retention areas, will surely be in accordance with this goal; for example with the restoration of natural floodplains some "free" services like nutrient retention (increasing water quality) and the development of richer biodiversity (Schneidergruber et al. 2004) are provided.

Create *recreational possibilities* is another important goal, because involving people in a beautiful, nature looking landscape can represent a valuable socio-economic positive aspect; for this reason the area of Steenbergsche Vliet and Tongelreep will be open to the public, offering recreational possibilities.

The *cooperation with the stakeholders group* during the whole planning process is a fundamental goal of all the four projects.

For example in the Steenbergsche Vliet project the water board Brabantse Delta will try to develop and implement its plan by means of an open planning process, where open refers to the fact that a close cooperation with local town communities, nature organisations, farmers and all other users of the area will be carried out.

This collaborative platform should also include the active *involvement of planning authorities*, this is assured by the introduction of the four water boards, the Province Noord-Brabant and the Hessian Ministry of Environment, Rural Development and Consumer Protection as project partners, but the involvement of several other kind of authorities at a local and regional level will strengthen this concept; for example the

German railway company (Deutsche Bahn AG) was informed and involved in the pre-planning process, because of the interference between railway and projected measure.

These two last goals are also clearly underlined by the EU WFD, which points its success to the close cooperation and coherent action of Community, Member State and local level as well as on information, consultation and involvement of the public including users.

The last two nofdp investment projects common goal are the consequence of the EU WFD focus on the catchment level, where all programmes of measures should be coordinated for the whole of the river basin. For this reason the transnational value of some nofdp investment projects and of the two transnational studies on the catchment areas of the river Mark and river Dommel (between Belgium and the Netherlands) are particularly worthwhile. Moreover the intensive exchange of data, models and above all knowledge, between the four projects will create a kind of experience platform, which will increase the idea of collaboration superior to political boundaries.

This classification of most important goals of nofdp investment projects was quite important in order to understand what are the main points defining the problem context.

In particular to analyse these projects seem to be a good starting point, because the nofdp IDSS will be developed under a continuous co-operation between the investment projects group as potential end-user (as test application) of the IDSS and the development group[3] as modelling experts (Winterscheid et al. 2004).

Unfortunately such a complicated problem context, summarized by the three layers approach of nofdp project also means difficult problems to solve and many conflicting alternatives to analyse; for this reason some kind of help is requested and at the end of chapter two it will be shown how such kind of support could derive from systems like DSS.

[3] Darmstadt University of Technology, German Federal Institute of Hydrology, Provincie Noord-Brabant and several external experts.

2 Theoretical background on Decision Support Systems

After introducing what nature-oriented flood damage prevention alternatives could signify, a literature research on Decision Support Systems was carried out with the aim of understanding which are the most important characteristics and conclusions about these systems.

Section 2.1 provides the reader with some general definitions on DSS; section 2.2 describes the field where a DSS has to work: the decision-making process (DMP), that is to say the process through which decisions are taken. Section 2.3 describes some basic functionalities and requirements of a DSS found in literature, while section 2.4 describes the basic structure components of a DSS. Finally in section 2.5 and 2.6 the reader can find some overall conclusions on benefits, limitations and difficulties developing DSS and above all some reflections on why a DSS seems to be a good solution for nofdp project objectives.

2.1 Definition

According to Marakas (1999) the concept of DSS is born in the 1970s and it is attributed to two articles of that time; the first one was written by J.D. Little (1970), entitled "Models and Managers: The Concept of a Decision Calculus"; here Little introduced the concept of a decision calculus like a "model-based set of procedures for processing data and judgements to assist a manager in his decision making". The second one was written by Gorry and Scott Morton (1989), entitled "A Framework for Management Information System"; with this second article the term Decision Support System was coined, in particular for the authors DDS couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions.

So the roots of DSS grew in a managerial context, in the effort to support managers with computer-based systems applying models to their daily problems, with the objective of improving the quality of decisions.

Nowadays the idea of DSS has acquired a considerable number of extensions from this first idea given by the two articles; we can find applications of DSS in many different fields from medicine to water systems; indeed the concept of "management" is no longer only applied to the economic field, but it also refers to non-profit subjects like water.

A more actual picture of what DSS represent can be given by the following definitions: “A DSS is a system under the control of one or more decision makers that assists in the activity of decision making by providing an organized set of tools intended to impart structure to portions of the decision-making situation and to improve the ultimate effectiveness of the decision outcome” (Marakas 1999) or “A DSS is a computer-based system which helps decision makers to confront ill-structured problems through direct interaction with data and analysis models” adopted by De Kok and Wind (2003) and finally “A DSS is both a process and a tool for solving problems that are too complex for humans alone, but usually too qualitative for only computers” (Westphal 2005).

In these definitions we can find summarized some fundamental concepts linked to DSS; first of all the fact that a DSS acts like a support, an assistant for decision makers (people in charge of taking decisions based, in whole or in part, upon the output of a DSS (Marakas 1999)), but it can not replace them; this means that system outcomes are not final and complete decisions, because the task of a DSS is not to make decisions, but to support them.

Secondly we find described how these systems manage to support the user, by providing him with organized tools, data and analysis models which give structure to the context where he has to make his decision; this is very important because DSS have to work in the field of messy problems, that is to say problems whose objectives are conflicting and for which the solution is not simple or evident. These kind of problems require nonprogrammed decisions, decisions that are novel, unusually consequential, not repetitive and that follow any kind of routine (Simon 1960), in other words they are too complex for decision makers alone, but as stated in the last definition too qualitative for only computers (this is also the case of problems of the new integrated view introduced by nofdp project).

Finally we find summarized the main objective of a DSS: to improve the ultimate effectiveness of the decision outcome, confronting the alternatives in a interactive way; that represents an evolution of what Gorry and Morton have called “quality of the decision”, that means that a DSS should decrease the gap existing between the theoretical optimum decision and the decision that will be made, in particular according to Marakas (1999) this gap can be represented by the degree to which the decision succeeds in reaching its objectives within the boundaries and constraints imposed by the problems’ context; he adds that a decision is a good one when it manages to solve the problem, without causing any new problems (the reader has to keep in mind this concept especially regarding the theme of ecology and future developments of it in this work).

In any case it must be taken into consideration that for real applications a DSS has to find a good balance between effectiveness and efficiency, because most of the time these two goals are in contrast.

In conclusion what a DSS represents can be well summarized by defining it like an assistant in exploring the decision space (Hahn and Engelen 2000), when a high degree of uncertainty arises in the problem context.

2.2 The Decision-Making Process

After giving some general definitions on DSS found in literature, now it must be analysed in what context such a kind of system has to work, that implies the analysis of the decision-making process (the process through which decisions are taken); this is of particular importance in order to understand at what step a DSS can act in such a process and in particular how it can support it.

One of the most simple and comprehensible concept theories on decision-making process (DMP) is provided by Simon (1960); he divided the entire process into four phases: the *intelligence phase*, the *design phase*, the *choice phase*, and the *review phase*.

During the *intelligence phase* the user is looking for information that can suggest to him that a decision has to be made, because of the presence of a problem.

The second phase is concerning the *design* and it is described by Simon, like the phase where the user has to invent, develop and analyse possible alternatives; after that the selection of one of the analysed possibilities has to be made and this step is represented by the *choice phase*.

Finally Simon calls *review activity* the action of assessing past choices.

What we can observe is that although this conception is very old and general, it manages to describe very well what the fundamental steps of a DMP are.

In addition to that now we have to understand at what moment and how a DSS can support such a process.

In figure 2.1 a graphical representation of the DMP and the field of competence of a DSS are shown.

This conception is proposed by the author of this thesis moving from the general managerial concept introduced by Simon to a more focussed application of the DMP in the field of water management (field where the nofdp IDSS will have to act).

In this schematisation five different phases can be found: The *monitoring phase*, the *cognition phase*, the *planning phase*, the *discussion phase* and the *action phase*.

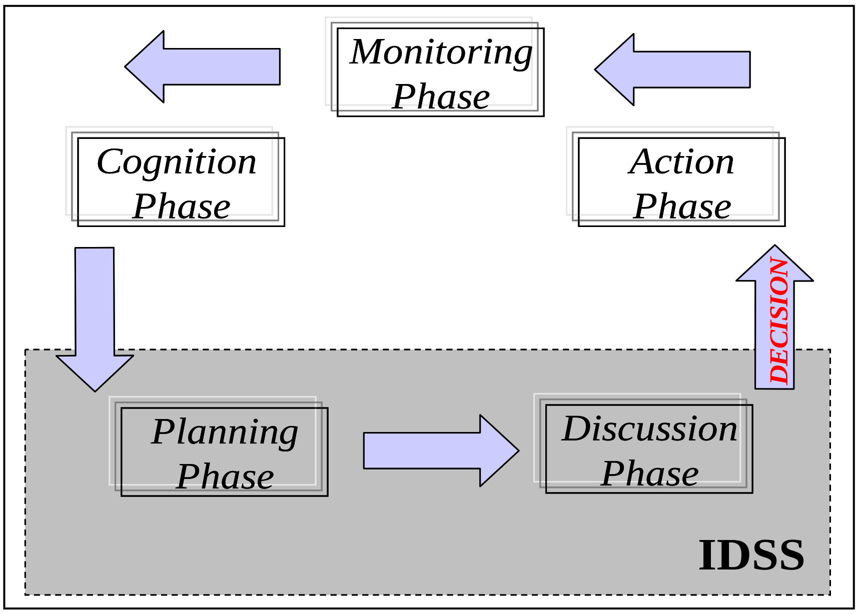


Figure 2.1: Field of action of a DSS in the DMP.

The cognition and part of the monitoring phase represent what Simon called in his theory intelligence phase. In particular during the *monitoring* phase a comparison between a desired state and the actual state (in the context of projects like nofdp, desired state is most of the times provided by policy requirements) is carried out; when a discrepancy between these two states is recognized, the *cognition* phase can start and here through a series of further steps towards the awareness that a problem exists (in the field of water management, this is frequently provided by the interaction between a strong stakeholder pressure and the relative authority involvement), a qualitative definition of the problem is achieved; with this step a large amount of conflicting alternatives arise and for this reason from now on the user can receive a great help from using systems like DSS.

With the introduction of the *planning phase*, the DSS starts supporting the user in making his decision, because the decision maker has to make an evaluation about different and most of the times conflicting alternatives; here a DSS finds its natural application, because of its capabilities of analysis. In fact the selection of an effective solution from a set of feasible alternatives is the essence of decision-making process and is the portion of it where a DSS is often more useful (Marakas 1999).

This phase finds a reflection in what Simon called design and choice phase, but what he can not imagine in his managerial context, is the introduction of a new phase, which we can call "*discussion phase*", here discussion refers to the iterative and interactive process which occurs next to the planning phase, when the final decision depends also on the expected agreement of different groups (for example as far as water management is concerned, it refers to the agreement of the different stakeholder groups and of the administrative level).

So a DSS concretely works in the planning phase, because it can help the user by selecting, the best alternatives, but the same information provided by the system (opportunely presented, for example by means of visualisation tools) could be well used in the discussion phase, where the user has to discuss and above all justify his choice.

In chapter three the reader can find further considerations about considering the nofdp IDSS like a "discussion facilitator", that means the possibility for the user to be supported by the DSS also in the discussion phase.

In any case after the evaluation and discussion of all possible alternatives, the system should manage to provide the user with significant and transparent information (it refers to the ability of the system of transforming the information base in a transparent and no black box system) in order to make his decision.

After that the *action phase* follows (always focusing on water management field, this corresponds to the implementation of real measures) and finally the monitoring phase can start again, this was also underlined by Simon, considering the assessment of past choices.

In chapter three together with all the considerations about who are the potential end users of the nofdp IDSS, the reader can find further conclusions about the DMP and what it looks like in the context of situations analysed by nofdp project.

2.3 Basic DSS tasks, requirements and functionalities

In section 2.1 and 2.2 parallel to DSS definitions and DMP description, the reader has already found some general considerations about important DSS tasks. These first concepts will now be extended in order to make the point on some important information found in literature.

This is of particular importance in order to provide a general literature basis to the profile of functionalities and requirements developed in chapter three focused on the nofdp IDSS.

First of all in order to make some concepts clearer for the reader, it will now be explained what words like task, functionality and requirement signify in this work.

In this first part of the thesis, the general meaning will be associated to these three expressions, because the goal of this section is only to give a generic picture of the way in which a DSS can help the user, with some further considerations on important functionalities and requirements for DSS in the field of water management.

In chapter three, with the construction of the profile of functionalities and requirements for the nofdp IDSS, these words will acquire a more specific meaning (refer to the glossary).

As already mentioned the main task of a DSS is to support the user in the DMP providing him with structured tools, data and analysis models in order to improve the decision effectiveness.

Marakas (1999) adds a lot of extensions to this basic and general task; some of the main important are summarized in table 2.1.

Table 2.1: DSS general tasks (adapted from Marakas 1999)

DSS general tasks
Increase decision maker's ability to tackle complex problems
Facilitate learning on the part of decision makers
Encourage exploration and reveal new approaches about a problem space or a decision context
Explore multiple perspectives of a decision context
Extend the decision maker’s ability to process information and knowledge
Provide control over multiple and disparate sources of data
Explore and test multiple problem-solving strategies
Explore multiple analysis scenario for a given decision context
Shorten the time associated with making a decision
Generate new evidence in support of a decision
Facilitate brainstorming and other creative problem-solving technique
Provide support for communication among multiple DSS users
Provide the presentation of data in a variety of formats

As we can notice these tasks are very generic, but this table manages to describe well what are some important features of a DSS; in particular we can notice that the main theme that links most of these items is the concept of extension and facilitation; that is to say a DSS extends the user capability of acting in the DMP, in particular by encouraging him to explore more complex problems, but also to investigate into new perspectives, because they become simpler to analyse with the help of a DSS. Moreover a DSS can help the user to communicate these new outcomes, because it is able to generate new evidence in support of a decision (this is closely linked with the ability of DSS to make its information transparent).

Another possible distinction based on DSS tasks, is provided by Marakas (1999) adapted from Alter (1980) classification of DSS; he distinguishes between data-oriented DSS and model-oriented DSS, where data-oriented DSS are focused primary on data retrieval and analysis support activities; while the model-oriented DSS include activities such as simulation, maximizing or optimizing scenarios; So a clear distinction from the point of view of functionalities emerges with this classification, because from one side there is the focus on data and from the other the focus on models.

Also Hahn and Engelen (2000) report this distinction, affirming that an Integrated River Basin Management DSS (IRBM-DSS, this is also the field of nofdp IDSS) clearly falls under the category of model-oriented DSS, because although data analysis and presentation are important functionalities for an IRBM-DSS, the highly complex and dynamical system linked with IRBM can only be represented well by means of an integral model.

Moreover Hahn and Engelen (2000) provide in their work a list with the most important IRBM-DSS functionalities; they are reported in table 2.2.

Table 2.2: Functionalities of an IRBM-DSS (Hahn and Engelen 2000)

IRBM-DSS functionalities
Analysis
Communication
Library (knowledge base)
Management
Learning

According to them the *analysis functionality* allows the user to evaluate the effects and impacts of planned measures; the comparison between current state, desired state and projected state is a natural part of this functionality; linked to this concept they place the *management functionality*, which refers to the ability of selecting, from a set of possible measures, those that fit best to the objectives.

The *communication functionality* is linked to the phase of the DMP, that was previously presented as *discussion phase*; it points at the possibility for an IRBM-DSS to facilitate the communication between users of the system and stakeholders; in particular to satisfy this functionality a great deal of transparency and user-friendliness is requested, because stakeholders need to recognize their own domain and to understand how their different views are related to each other. Moreover the speed of responsiveness of the system is also an important requirement during brainstorm sessions, which can be seen as part of the discussion phase.

A user friendly system improves also the *learning functionality*, which allows the user to learn about the linkage of processes, because experts are familiar with dependencies in their special field, but the multiple interdependencies of a complex system can be unknown to them.

Finally the *library functionality* derives from the idea of seeing the IRBM-DSS like a knowledge management infrastructure or a sort of dynamic library; it can gather, order and link existing knowledge, but above all it makes knowledge available in operational form; we will see how, also for the nofdp IDSS, this functionality is typically satisfied by a system component called knowledge base (refer to next section).

Some requirements, essential for a good implementation of this basic profile of functionalities, have already been mentioned, for example the communication and learning functionalities requires a great deal of transparency and user friendliness.

Other general system requirements can always be found in the paper of Hahn and Engelen (2000);

They focus their attention on the notion of generality and flexibility, because in their opinion, it is very important to create as soon as possible in the development phase of the DSS a general and flexible architecture, which could transform the DSS into a "generic tool".

In particular we can understand what "generic" could signify, if we think that an IRBM-DSS should be applicable to many river systems, that implies to reuse it and eventually extend it in order to apply it to more than one area;

The problem is that requirements like generality, flexibility and reusability don't come for free and the technical cost for such a structure can be very high; so an important question during the system development is to define the extent of generality.

Of course the requirement of generality is of relevance for all the functionalities listed in table 2-2.

Finally it can be summed up that this section provides an overview on general DSS and IRBM-DSS tasks, functionalities and requirements, but during the development of the DSS a definition of the key functionalities has to be done, because a DSS can normally not satisfy all of them well at the same time (Kofalk et al. 2001), so a kind of prioritizing of functionalities is requested.

In chapter three the reader will find the analysis that leads to the definition of nofdp IDSS profile of requirements and key functionalities.

2.4 Basic system components

After understanding for what purposes and with what functionalities a DSS can be used, the technical basic components of a DSS will now be described.

First concept that the reader has to keep in mind thinking about DSS structure is that, in order to serve most of the tasks mentioned in section 2.3, its component parts should be something more complex, than a model; a model is a single, simple algorithm for the solution of special, well defined problem (Kofalk 2001), while a DSS has to act in the field of messy problems, where conflicting alternatives and multi-disciplinary approaches have to be considered, we will see how this concept finds inevitable reflections in the system structure.

The difference between data-oriented and model-oriented DSS provided by Marakas (1999) and adapted from Alter's classification has already been mentioned; this simple old classification already introduces the necessity of two fundamental structure components: the data base and the model base.

In particular Marakas (1999) recognizes as component systems, five elements:

the data system, the model system, the knowledge engine, the user interface and the user(s).

In particular this classification is in agreement with the system architecture adopted by Hahn and Engelen (2000) for their IRBM-DSS.

A graphical representation of this structure is provided in figure 2.2.

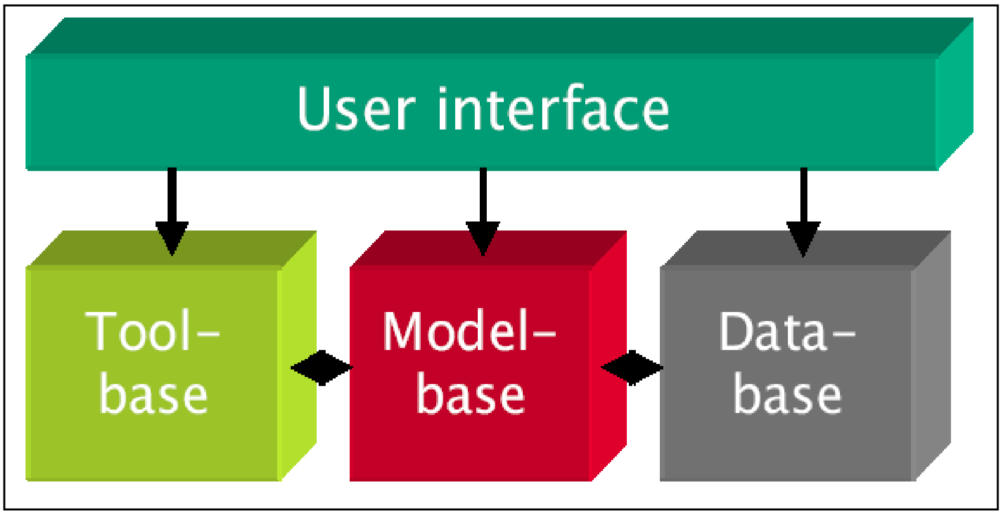


Figure 2.2: Basic system components of an IRBM-DSS (Hahn and Engelen 2000).

Combining these two theories, we can conclude that the main components for a DSS are:

- the data base
- the model base
- the tool base
- the knowledge base
- the user interface

Finally according to Marakas also the user should be considered as a system component.
The components will be described in this order, starting with elements far from direct access for the user and ending with more superficial and directly accessible components, where the user can be also considered as integral part of the system architecture.
The *data base* is perhaps one of the most important components of a DSS, because its quality and structure, can determine the success of the DSS; in particular we can define it like the system component, where the various activities associated with retrieval, storage and organisation of the relevant data for the particular decision context are managed (Marakas 1999); in other words the data base is the component that facilitates the user with the management of data; this is of particular importance for water management DSS, where the basic data requirement is very wide; moreover the necessity of a great amount of spatial data makes the link necessary between the DSS and the GIS (Geographic Information System).
Although the common notion associated with data is linked to numbers and model inputs, we will see how a DSS such as the nofdp IDSS, should have the ability of managing other kind of information; examples are heuristics, rule of thumbs, best practice examples and so on; we will see how this particular kind of data could be stored in an other DSS component: the knowledge base.
Next component is the *model base*, which can be defined like the component that, regarding the field of water management, contains all the statistical and physically based models, that is to say all the specific domain models necessary to the problem environment.
Marakas (1999) recognizes the added value of DSS in comparison with other computer-based information system, in this component; indeed a model base permits the DSS to run individual or combined models; this is what gives the DSS the possibility to approximate as much as possible a good solution for a given problem (Kofalk 2001).

In chapter three, analysing the technical feasibility of the profile of requirements, some further comments on models and the model base for the nofdp IDSS will be added.

The idea linked with the *tool base* is always something that results unclear; sometimes it is considered like an integral part of other system components, like the user interface or the model base; but its large variety of tools surely constitutes a key success factor in a DSS and for that reason it is important to consider it alone.

This component incorporates tools to describe, compare, present, rank and evaluate the different alternatives; these tools can be described like the gnomes that will carry out the many small technical tasks in the background of the system (Hahn and Engelen 2000);

The *knowledge base*, can be defined as the system component where the “knowledge” of the DSS is stored; knowledge here refers to rules, heuristics, boundaries, constraints and any other “knowledge” that has been programmed in the DSS by its designer (Marakas 1999).

It has already been underlined the possibility for the DSS to manage data not only in form of numbers or model inputs, but also in form of information, for this reason a natural requirement for the knowledge base is to store these information; but its functionally goes further, in that the knowledge base provides the user with selected and analysed information, in other words the data provided by this component are “knowledge-oriented”.

This is perhaps one of the most sophisticated components of a DSS, because with its functionality the system tries to approach, one of the typical functionalities of human behaviour: “reasoning”, intended like the process by which new information is derived from a combination of existing or previous derived information (Marakas 1999).

The information contained in the knowledge base should be problem domain-specific, that is to say containing only the knowledge necessary for the problem solving context (Marakas 1999), we will see how the nofdp IDSS will only partially conform to this idea, in that one of its objective is to be reusable in the North-West territory and for that reason reusable in many decision making contexts.

Finally always in chapter three we will see how some further discussions have to be done, if the knowledge base has to be integrated in the DSS or it has to run as an independent component.

The *user interface* is the component that allows the user to access the internal components of the system, but also all the results produced by the DSS in a relatively easy way, hiding the complexity of the system itself (adapted from Marakas 1999); as a consequence a good designed DSS could also have powerful functionalities, but without a good user interface, these remain inaccessible;

Lack of user-friendliness or familiarity with the system has led to the fact that practical application of DSS still runs behind the availability of these tools (De Kok and Wind 2003).

As a consequence to provide inside into the structure of the DSS in a user-friendly way, is a vital task of the user interface.

A Graphical User Interface (GUI) can good facilitate the contact between the user and the system (also the nofdp will obviously be graphical).

The crucial problem arising with the design of the user interface, is the choice of the DSS end users and this choice is of great importance not only in the design of the user interface, but in the design of the whole system; theoretically the user interface should reflect the way of thinking of the user and for that reason the action of selecting the users of the system is a crucial aspect in the DSS design.

Finally as mentioned before some considerations about the *user* of the system have to be done, because although he is obviously not a system component, his influence is so strong, that he can be considered as much part of the system as the other architecture components.

The user of a DSS can be defined like the person or people, responsible for providing a solution to the problem at a hand or for making a decision within the context the DSS was designed to support (Marakas 1999).

This is a very general definition and as it can be observed, a person with such characteristics may not actually ever use the DSS. So some further definitions and researches in order to specify what are the possible roles of DSS users have to be effectuated.

In chapter 3 the reader will find other information about DSS users and above all the definition of who are the possible users of the nofdp IDSS.

2.5 Benefits, limitations and critical factors developing DSS

At the end of this overview on DSS, it is now important to focus the attention on what are the benefits, but above all some of the most important limitations and critical factors in the development of such systems.

As far as *benefits* are concerned, they are all linked with the implementation of the tasks described in section 2.3; we will see in section 2.6 how some of these benefits constitute the reason why a DSS seems to be a good solution for nofdp project objectives.

As a synthesis we can say that most of the benefits of a DSS relies on the fact that it extends the possibilities for users to act in the decision-making process when he has to handle messy problems, shortening the time linked with it, improving the effectiveness of the decision outcome and giving him the possibility of sharing these outputs with other actors involved in the decision making process.

Moreover we have to underline that if the system succeed in providing the user with a great deal of transparency on how information are generated, the DSS can generate new reliable evidence in support of a decision, because a decision maker trusts what he perceives as a transparent and no black box system.

On the other hand it is much more important to underline *limitations* linked with such systems. In table 2.3 a list of most important limitations for DSS is reported.

Table 2.3: Some of the most important limitations of DSS

DSS limitations
A DSS has to support the user and not replace him
A DSS only contains the knowledge given by its designers
A universal DSS can not exist, it must be created with a narrow scope
A DSS can not provide the user with “the best” solution

First of all it was already mentioned that a DSS can support the user, but it can not replace him; this is an obvious limitation if we think that a computer system doesn’t contain human skills such as creativity, imaginativeness or intuition (Marakas 1999).

Secondly another limitation is provided by the fact that a DSS only contains the knowledge given by its designers. Moreover because of the unique nature of the problem context, a universal DSS can not exist, but it should be designed with a narrow scope of application (Marakas 1999) and to solve more complex problems, several DSS are required; for this reason a lot of difficulties arise in the effort to make the DSS as much general as possible. In any case as already mentioned in section 2.3, for the application of DSS in the field of IRBM, the system should be reusable to other river basins with similar characteristics and this gives some important boundary conditions to the extent of generality and reusability.

Finally another important limitation is the fact that DSS support the user in making his decision, but they are not designed to provide him with “the best” solution, that is to say the outcomes of a DSS are still “open” for the discussion phase of the DMP. Moreover according to Simon (1960) the search for an optimal solution is without meaning, because the cognitive limitations of man makes it impossible to consider all the possible alternatives for a particular problem; as a consequence most of the times the best solution is out of the search space and for that reason impossible to reach, that represents what Simon called "boundary rationality"; for this reason a DSS doesn't provide any best solutions, but effective evaluations about feasible solutions, which are open to further improvements coming from the discussion phase.

This concept is very important because if the system gives the illusion to lifer best solutions, non-experts could play around with the system, thinking that an expert judgement is no more required (this is also a natural consequence of a too accessible GUI) (Schielen 2000).

As last step some common *critical factors* arising in the development of a DSS are listed in table 2.4.

Table 2.4: Some of the most important critical factors developing DSS

Critical factors developing DSS
Lack of clear purposes in the initial phase of the DSS development
Failure in address user requirements, users are not integrated or are integrated too late in the development of the DSS
Failure in address the problem changing context and user changing needs
Lack of flexibility
Lack of user friendliness/System complexity/lack of transparency

As already mentioned in section 1.3 the first critical factor refers to the lack of clear purposes in the initial phase of the DSS development, for this reason the first task (refer to section 1.3) completed by this thesis was to give a clearer picture of the problem context and of the most important goals of nofdp project. Also De Kok and Wind (2003) underline the concept of a solid analysis of the problem from an integrated point of view and a clear statement of purpose of the DSS as essential condition in successful DSS design.

Secondly there is a strong agreement in DSS literature on the fundamental role of the user. Indeed many difficulties developing DSS arise because this role is frequently neglected or it is considered too late. This makes the design of the DSS technological driven and as a consequence the users are confronted with the system only in a later phase (De Kok and Wind 2003); this is could represent a critical factor for the success of the DSS, because the designed users can not accept the system, because it doesn't reflect their needs. For this reason the selection of the potential user of the DSS is an important action of the development phase and it has to be done as soon as possible, because redesign the DSS could require too high costs.

In addition to that, the role of the user may change and also the problem context may become something different; examples are new policy strategies, tendencies or simple new user demands, which the system is not able to handle.

For this reason a lack of flexibility in particular in the system architecture can be very negative for the DSS; moreover a flexible structure is vital not only for the inevitable changes in the problem context or in user wishes, but also in the effort to reuse the DSS to other similar areas.

Finally another point on which the DSS literature is in clear agreement is the fact that the DSS should necessary has a user-friendly, attractive and as much graphical as possible user interface. Indeed the system complexity and the lack of transparency can generate indifference from the part of the users and suspects about the effective objectivity of system results.

In particular as underlined in the DSS-Large rivers project, the challenge is to design the user interface in a way, that reflects and meets the way of working and thinking of the users of the system (One of the most interesting features of DSS-Large rivers is to define measures in a language, which meets the terminology of river managers (Herman et al.)).

Once again the concept of user-friendliness is linked with the definition of the users of the system, which will impact not only the user interface, but the whole system.

Finally some more technical critical factors like lack of data or high costs in the development phase are not to be forgotten.

2.6 Conclusions (why a DSS seems to be a good solutions for nofdp)

After the description of the problem context faced by the nofdp IDSS and the selection of the most important reflections about DSS, the purpose of this last section is to understand if a DSS could be a good solution for nofdp goals, because in the initial phase of such projects, there should be a clear idea of the reasons why a decision support system is needed (De Kok and Wind 2003).

As a consequence it can be observed that a DSS is needed by nofdp project because the nature of problems arising in the new three layers approach is surely “messy”; indeed considering the contemporary action of human, ecological and technical issues, makes the problem to solve very unstructured and difficult to solve.

Secondly the fact that nofdp project try to represent the river system as integrated, brings to the necessity of a model base instead of one model; the processes and the interrelations between all system components are too complicated in order to be well represented by a single model. The difference is between a single algorithm applied to solve well defined problems and a DSS model base, containing many models capable of forecast trends and tendencies in a multi-disciplinary field (Kofalk et al. 2001). Obviously also the data and knowledge base of a DSS seem to be very useful because of the large amount and variety of data and information, that considering the river system as integrated implies; in particular the nofdp common goal of exchanging data, models and knowledge can be well satisfied using the DSS data and knowledge base as a big "common information platform".

It has already been mentioned how an important item of the nofdp problem context definition was the cooperation with the stakeholders group and the administrative level; it was also defined that the field of competence of a DSS in the DMP is represented by the planning and the discussion phase, as a consequence the strong visualisation and presentation tools of a DSS, make the mentioned cooperations possible and above all a DSS could give new evidence and transparency for all the actors involved in this two phases of the DMP.

The nofdp goal of improving the transnational cooperation seems to be good coupled with the mentioned ability of a DSS to be reusable to other similar project areas, for this reason a well designed DSS could be used not only for the four investment projects, but also to other similar river basins.

Finally it can be seen that, even though the nofdp problem context seems to be very complicated because of what the integrated view implies, a DSS could manage well in helping the user in such situations, always keeping in mind the limitations of such systems analysed in section 2.5.

3 Concept of an Information and Decision Support System applied to nofdp

After understanding that a DSS can be a good solution for nofdp project problem context, now it remains to start thinking about how to design it; in order to accomplish this task, two fundamental questions have to find an answer, that is to say who are the potential users of the nofdp IDSS and what are their needs. For this reason section 3.2 and section 3.3 give a proposal on who could be the users and what could be a profile of functionalities and requirements for the nofdp IDSS.

Section 3.1 explains which approach was chosen for the analysis, while section 3.4 lists some general considerations about the technical feasibility together with other general conclusions.

Finally what is important to underline is that in this second part of the thesis, the report takes the connotation of an "experience report", because parallel to literature considerations, most of the outcomes are the result of project developments and meetings, which I partly personally took part in.

3.1 Top-down approach

The problem faced by this section is to understand which approach could be more appropriate in order to start with the concept on the nofdp IDSS; after some literature researches it seems clear, that it exists two methods to develop DSS: the bottom-up technique and the top-down technique.

The bottom-up technique consists on looking at the available possibilities from a technical point of view (models available) and try to make some considerations on how to select and above all to couple them, it looks like a very rational, scientific kind of technique, but the problem is that considering only what it exists from a technical point of view prevents most of the time from new outcomes and the risk of loosing important requirements is very high.

Moreover the focus on the users of the system is quite neglected and the human component is less considered; we have already mentioned as critical factor in DSS development the inexistent or later involvement of the user.

For this reason an effort in order to consider the role of the DSS users has to be done.

The top down technique seems to better accomplish to this goal, in that before selecting the models for the model base, the major requirement of this technique is the availability of a tightly defined purpose for the DSS (Van Dijk 2004). That implies to make some analysis and considerations before starting with the selection of the models.

In particular we can try to understand how this approach should be carried out, summarizing what are the fundamental steps for two projects which have developed DSS with a top down technique.

During the design with this technique of the wadBOS DSS (created with the purpose of supporting policy making in the Wadden sea) three knowledge-acquisition sessions were organized, where a gradual system analysis of the Wadden system with a view to obtain a system model was carried out (Engelen 2000); in the first section a large group of potential users of the system were interviewed, in addition to this the analysis of literature and policy documents was carried out; at the end of this phase the main processes were identified. In the second session a large group of selected domain experts was interviewed and at the end a visual description of the Wadden system was ready to translate its qualitative models into mathematical representations. Finally the third section was aimed at confronting users, domain experts, scientists and model developers with the mathematical representations.

Another case of top down design is the Elbe-DSS (which ultimate goal is to develop a generic tool that helps water managers to formulate policy for river basin management and to take appropriate measures to realise policy objectives (de Kok et al. 2000)); in this case the Elbe river was selected as a case study, the users were selected (IKSE, federal and state institutions, biosphere reserves) and an intensive discussion with these potential users was carried out; after the specification of the users demands, the system diagram was developed and the spatial and temporal scale were determined; these two actions formed the basis for the models selection.

From these two examples the essence of the top down approach can be well extracted, that is to say it implies to gather all the relevant knowledge and information about the problem context in order to convert them later into a models selection.

In section 3.3 this thesis will try to approximate this approach proposing an analysis of several documents judged relevant for nofdp project; the result will be the definition of a profile of requirements and functionalities for the nofdp IDSS.

3.2 Definition of potential users for the nofdp IDSS

As defined in the previous section, trying to start a top-down approach for the design of a DSS implies gathering all the relevant knowledge and information about the problem context faced by the nofdp IDSS, this means try to extend the first general concepts on the nofdp investment projects common goals described in section 1.3.

In particular, as also underlined in the Elbe DSS development phase, the attention should be mostly posed on the users of the system; moreover it was already mentioned in section 2.5 how the failure addressing users requirements is a clear critical factor in DSS development. For these reasons this section tries to give some proposals on who could be the potential users of the nofdp IDSS.

First of all a brief literature research about DSS users was carried out, in order to give a theoretical background to the later developments.

In section 2.4 the user of a DSS was already defined as the person or people, responsible for providing a solution to the problem at a hand or for making a decision within the context the DSS was designed to support (Marakas 1999).

De Kok et al. (2000) define the users of the system, like the persons or institutes who can be identify as problem owners.

As already underlined a person with such characteristics may not actually ever use the DSS.

Marakas (1999) makes further specifications pointing to the *end user* as the person, who directly interacts, operates and communicates with the system, while as *decision maker* he defines the person in charge of taking a decision based, in whole or in part, upon the output of a DSS (Marakas 1999).

As we can notice in these two simple definitions, a difference emerges between users that directly use the system and those who mostly use the outputs of the system.

Finally Marakas (1999) recognizes another type of user, called *intermediator*, who theoretically serves like a filter or interpreter of the output of the DSS; one can comment on the fact that if the DSS is very transparent and user friendly, the DSS itself can be the intermediator.

When thinking about the decision making process as described in section 2.2, one can observe that an important actor of this process is missing in all these definitions, that is to say the stakeholders, Hemmati (2002) define them like those who have an interest in a particular decision, either as individuals or representatives of a group. This includes people who influence a decision, or can influence it as well as those affected by it.

So as it can be summed up from these definitions, the main actors involved in the two phases of the DMP, where a DSS has to work (planning and discussion phase, refer to section 2.2), are the end user, the decision maker and finally the involved stakeholders; the end user directly communicates with the system, the decision maker makes the decision also referring to the outputs of the DSS and the stakeholders could find some answers to their questions, if the DSS manage to represent some information in a very understandable way.

Now it has to be understood, who are the users of the nofdp IDSS.

First of all it can be observed that such theoretical definitions as described before seem to reflect well, what it can be found in reality by water boards. Indeed, due to doubts on who could be the users of the nofdp IDSS, the project partners decided to make a section of interviews with potential users of the systems; what I could personally notice, was the fact that the working process in particular of Dutch water boards can reflect well the actors described in the previous definitions; many interviewed people (mostly project leaders) answer to the question about the description of their work, stating that they have to prepare in the water board a kind of “vision” on which the administrative level has to make the decision and moreover they have to be able to show some information to the stakeholders group in case of hard conflicts situations (this aspect was also underlined at the German water board involved in the project).

On the contrary some interviews carried out by the administrative level and by consultants, show that by the administrative level, there is little possibility of application for a DSS, because most of the time the authorities involved have to make evaluations on plans confronting them with directives and legal aspects, so one of the most important characteristics of DSS doesn’t exist anymore, that is to say to handle messy problems, because confronting plans with legal aspects is a very structured kind of problem (that was particularly underlined in a German interview). Interviews with consultant engineer offices give more interesting results in that water boards may require external consultants for heir hydrological calculations and this time the consultant office could represent the *end user* and the water board the *intermediator* for the administrative level and partly for the stakeholders group.

Secondly it has already been mentioned that users of the system could be represented by problems owners, as consequence if we refer to the problem context of the nofdp IDSS as defined in section 1.3, we have to remember that it was derived from the analysis of the nofdp investment projects common goals, where problem owners are the four water boards integrated as project partners.

In figure 3.1 a schematic representation summing up what stated before is provided for the reader.

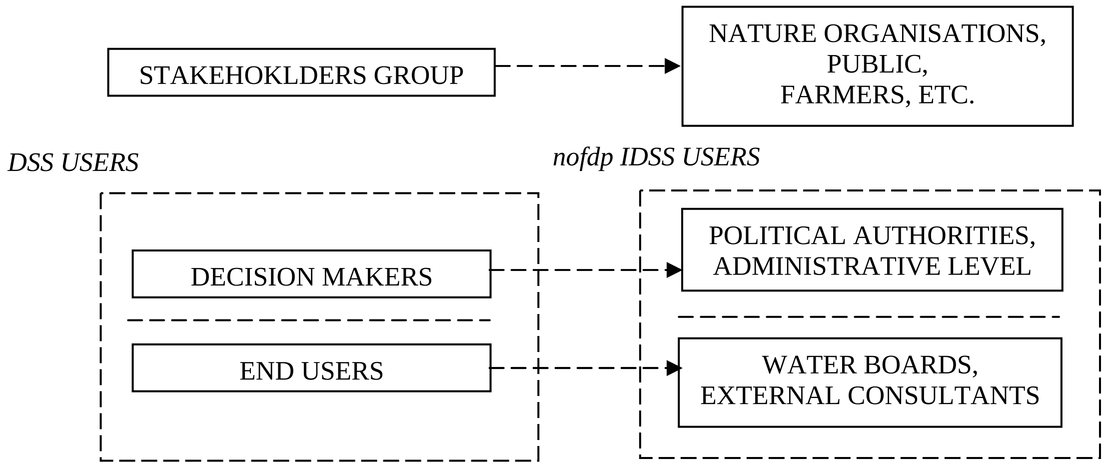


Figure 3.1: Schematic representation of possible DSS and nofdp IDSS users.

In this schematic representation the user, who will directly interact with the nofdp IDSS are water boards and external experts, in case water boards decide that model calculations have to be done in outsourcing modality. The administrative level and the stakeholders group will be supported by the DSS in a more indirect way, they will not be working with the system, but their consensus could depend on the output of the DSS and moreover on how much transparent and understandable these outputs are. This concept has to be underlined, because as mentioned the system should not give the impression to be accessible to non-expert.

Finally I want to underline that the selection of potential users by nofdp project was a very difficult task and also the projects protocols and some working meetings, which I personally took part in, didn't give a clear unilateral agreement on this theme.

Reasons can be probably be attributed to the fact that it was difficult for project partners and obviously for me too, to be able to select a group of individuals that could be interested in using the system, when only thinking about a very general kind of problem context as the one defined in section 1.3. Indeed in the top-down approach examples analysed in the previous section, a common characteristic is the fact that they are both applied to one singular defined case study (the Wadden see and the Elbe river basin) and by this way these projects manage well in defining the users of the system and in providing real names for these people.

For the nofdp IDSS this task is much more difficult, because the case studies involved in the project are four and they are also located in two different countries (Germany and the Netherlands), with some comprehensible differences in the way in which water is managed.

As a consequence, we will see that the profile of requirements developed at the end of this chapter can not only depend on potential users interviews, because of the great deal of uncertainty still linked with this theme; a shift of attention towards DSS functionalities is required (this was also a conclusion of an important Internal Workshop organized for project partners in the month of March).

Moreover, always linked to these uncertainties in defining the nofdp IDSS users, a prototyping approach seems to be necessary, where prototyping refers to the idea of an iterative design and development method with the ability to change the product mid-course in response to changes in the desired functionality or the availability of material for incorporation (Engelen 2000), such a kind of approach is required when the exact contents of the system remain slightly vague. Obviously a prototype approach needs potential users to test it, for this motive during the International Workshop (organized for October 2005) a test version of the IDSS will be presented to the invited people in order to have some feedbacks. Considering the long term, I think that more collaboration with the investment projects should be carried out, because they are integrated as project partners and as stated before they are at the moment the most probable problem owners as far as nofdp problem context is concerned, for this reason a well integrated prototyping approach could be effectuated with them.

3.3 Definition of nofdp IDSS profile of functionalities and requirements

After defining who could theoretically be the potential users for the nofdp IDSS, in this section an analysis of relevant documents for the nofdp problem context is carried out, in order to define a profile with the most important functionalities and requirements for the nofdp IDSS. In section 3.3.1 some explanations and comments on the adopted research method are provided for the reader; section 3.3.2 reports the first result of the research, describing which are the derived nofdp IDSS functionalities. Sections 3.3.3, 3.3.4, 3.3.5, 3.3.6 describe the results obtained analysing the nofdp project developments, the interviews with potential users of the system, the Internal Workshop role plays and some relevant policy documents.

3.3.1 Research method (explaining how the analysis is carried out)

Before starting with the explanation of the adopted research method, it must be better specified the meaning of the terms: functionality, requirement and objective. In section 2.3 the general meaning was associated to these expressions, because purpose of the section was only to provide a general literature basis to this part of the work.

Now I will refer to the expression *requirement* pointing to a general characteristic that the system should possess; with the expression *functionality* I consider a wider concept, in that a system functionality can be seen like a kind of “box” containing many similar requirements expressing the same need. Finally the word *objective* refers to the reason why a requirement should be implemented into the system.

As already mentioned in the previous section, due to difficulties in defining the IDSS users, a shift towards IDSS functionalities and requirements is necessary.

The following sections describe the results of the analysis carried out on different types of documents judged relevant regarding nofdp project.

The documents that I consider relevant to analyse are listed below:

- nofdp project developments
- potential users interviews
- Internal Workshop role plays
- Relevant policy documents

As stated in section 3.1 starting point of a top-down approach is to gather all relevant knowledge for the DSS and try to translate this into models.

For this reason this work tries to approach this method analysing some relevant documents about nofdp project.

The analysis of *nofdp project developments* is the starting point of the research; because in my opinion, the first requirements regarding how the system should look like have to be provided by project partners; fortunately by nofdp project all the working meetings were minuted and the minutes of these meetings between development group partners, investment projects partners and external consultants are very valuable in order to have a first draft of wishes about the system; in this part of the analysis also other relevant documents of the project such as the project overview (Winterscheid e al. 2004) and the project flyer are analysed.

The second part regards the analysis of eleven *interviews with potential users* of the system, carried out due to the doubts about the definition of users of the nofdp IDSS. Eleven people, acting at different levels in the decision making process, were interviewed in Germany, the Netherlands and Belgium; as affirmed before this part of the analysis is very important, because of the fundamental integration of users requirements in the development of the DSS, but at the same time all the uncertainties about the exact definition of nofdp users, make this part not sufficient alone.

The third part regards the analysis of four *role plays* (simulations of typical decision making situations where a DSS could be used, in order to observe the needs and wishes of the actors involved), which were carried out during the Internal Workshop organised in the month of March. I judged these information as relevant, because during such simulations an observer can have a better and wider insight in the whole decision making process, observing many actors, on the contrary for example an interview with a potential user only reflects the needs of that actor, missing the links with the other actors. In any case one has to remember that they are always simulations and once again analysing only such information is not enough.

Finally the last part is represented by the analysis of some relevant *policy documents*, because such type of documents can give us a future image of which will be the trend of development regarding the examined problem context (for example the most important EU WFD objectives will be reached in 2015).

Obviously this is perhaps the most valuable part of the analysis, because of the provided future prospective; but policy documents regarding nofdp alternatives are very numerous and the time linked to the analysis of most of them is not compatible with the time agreed for this thesis, so for the purpose of this work some brief comment will be done about two European Directives judged relevant.

So what can be commented on is the fact that even though the attention can not only be focused on users requirements (because of the mentioned uncertainties about users definition), such a kind of research work can be valuable in the selection of requirements for a top-down technique, because it consists of analysing different relevant information and put them together (just like a kind of “puzzle”). The idea is that collecting information from all these different points of view will give a quite complete image of the IDSS functionalities and relative requirements;

After the selection of most important documents to analyse, another step of the research is to decide how to manage this big amount of information, because a kind of synthesis and reduction is absolutely necessary.

In the month of April a working meeting, which I personally took part in, managed to provide a good solution to this problem in the effort to analyse the potential users interview; for this motive I decided to apply this research method to my whole analysis.

The first step of the method consists of reading the examined documents compiling a "brain-storm" list of all the items that directly or indirectly express a requirement on the system or an objective that the system should reach; secondly all the items that seem to express the same need are grouped in major categories (these major categories will be the nofdp IDSS functionalities as defined at the beginning of this section). After that a further reduction and synthesis of information is required, because the amount of information is still too big and as I could notice, many requirements and objectives within the same functionality still express the same need, for this motive similar items are grouped once again for every functionality. Finally for every group of linked requirements and objectives a final synthesis is provided.

In the next sections the reader can find only the final synthesis with some considerations about them; the complete list of functionalities and requirements is provided in the appendices.

3.3.2 Definition of the nofdp IDSS functionalities

After understanding how the research was carried out, in this section the first result is presented to the reader, that is to say the definition of the nofdp IDSS functionalities.

A list of these functionalities is provided below:

- communication
- model calculations
- toolbox
- evaluation

This functionalities scheme seems to be able to contain all the distilled requirements; reasons could be attributed to the fact that the listed functionalities partly remember the basic system structure as described in section 2.4, where the communication functionality could be associated with the user interface, the model calculation functionality with the model base, the toolbox functionality with the tool base and finally the evaluation functionality with a system component not mentioned in the examined literature, that is to say the evaluation scheme (further considerations on the nofdp basic system structure can be found in section 3.4.1).

The first functionality is *communication* and as also underlined in section 2.3 it is linked to the possibility for the users of the DSS to be supported during the discussion phase of the decision making process. We will see in the development of the analysis how the requirements belonging to this functionality mostly point to the way in which the output of the IDSS is represented and if this output is easily accessible.

Secondly we find the *model calculations* functionality and as we will see in the course of the analysis the requirements linked to it mostly refer to calculations and as a consequence to the models of the model base (e.g. spatial and temporal scale).

The next functionality is the *toolbox* and always considering the results of the analysis, it can be stated that this is the functionality which put together two information in order to generate a new information based on rules or logic.

Finally we find the *evaluation* functionality, where its requirements mostly refer to the fact that the model calculations and other information need some post-evaluation in order to provide the user with further support, for that reason the nofdp IDSS will be equipped with an evaluation scheme (refer to section 3.4.1).

In section 2.3 it has already been mentioned that during the development of a DSS a definition of the key functionalities has to be done, because a DSS can normally not satisfy all of them well at the same time (Kofalk et al. 2001); it was also observed that a kind of prioritizing of functionalities is necessary. Now after the definition of nofdp IDSS functionalities, it has to be observed that if a prioritizing is needed, the main contrast arises between a DSS which can facilitate the communication between policy makers and stakeholders in a participative planning efforts (Hahn and Engelen 2000) or a DSS which doesn't claim to bridge the gap between policy makers and domain experts, but merely to provide an integrated assessment of impacts of flood management measures and assisting the analyst in making such assessments (Van der Most et al.).

In other words developing the DSS with the purpose of using it in a participative planning context implies to pose the accent on the communication functionality, while developing it with the purpose of carrying out integrated assessments of the considered measures supporting experts, implies to strengthen in particular the model calculation functionality.

Once again, also regarding the prioritizing of the functionalities of the system, the choice of the users of the system is a key action of the DSS development phase. The proposed conception on nofdp IDSS potential users points to water boards and engineering offices as potential end users of the system, but also recognizing the administrative level and the stakeholders group as participating in the decision making process. Moreover as also underlined by the interviews with potential users some differences arise in the way of working of water boards in Germany and in the Netherlands, for example the concept of participatory planning process seems to be more influent in the Dutch water boards (also refer to the open planning process implemented in the Steenbergsche Vliet nofdp investment project).

In any case one should remember that facing a problem within an integrated approach necessarily requires another kind of participative context, because in such problems many different experts with different type of knowledge are involved; for this motive the communication functionality has to be developed with the minimum target of managing in supporting this kind of participatory context.

For all these reason a kind of balance between these two functionalities (communication and model calculations) has to be found, because both of them seem to be of priority for the nofdp IDSS.

In any case just like for the definition of end users, also the prioritizing of functionalities remains an open question to which the project partners should give an answer as soon as possible.

3.3.3 Analysis of nofdp project developments

As it has already been mentioned in the previous section, the analysis of the minutes of project meetings, the project overview (Winterscheid et al. 2004), the project flyer and other project working papers is a necessary starting point in order to make some conclusions on the expectations that the nofdp project group has about the system.

Moreover the integration during working meetings of the investment projects group (the four water boards), gives some added value to this first part, in that according to the proposal of section 3.2 the IDSS end users are working at water boards.

The synthesis of the results as far as the communication functionality is concerned, are provided in table 3.1. The synthesis includes the requirements and the linked objectives.

Table 3.1: Synthesis of requirements and objectives for the communication functionality (nofdp project developments)

Synthesis for the communication functionality-nofdp project developments
R[4]: The IDSS end user should always have the possibility to understand how and where the outputs of the model base are generated, when not enough the system has to be spilt up in many parts O[5]: Provide the user with as much transparency as possible avoiding a black box system
R: The IDSS should be equipped of representation instruments (maps, graphs, tables, indicators, etc.) O: Try to represent the model output and make it more comprehensible in particular for the public
R: The IDSS should provide information in a balanced multi-sectoral point of view O: Harmonize the conflicts of interest that could arise during the planning process
R: The IDSS should support the discussion phase of the DMP O: Use the IDSS in meetings where decision makers and consultants have to discuss different alternatives with the stakeholders involved
R: The IDSS should underline the benefits linked with nature oriented flood damage prevention alternatives O: Improve public participation and acceptance in the planning process

It can be commented that the first requirement belongs to the general requirement of user-friendliness, in particular the concept of transparency refers to the idea that the user should always have the possibility to understand how and where the model output is generated and what it should be in any case avoided is a black box system, because the user can not trust model results and feel uncertainty on what is forecasted. Results have to be as much understandable as possible, that is to say only model results in form of numbers are not enough. Also a too detailed system analysis has to be avoided, it seems better to give descriptions of relevant processes and eventually if possible to consider particularities, because a DSS has to reduce the complexity and not to improve it.

Finally a proposal is to split the IDSS in many parts in order to provide every user with the right information depending on his level of knowledge (also refer to the system basic structure in section 3.4.1).

The second requirements refers to the notion of presentation of models outcomes; once again model outcomes can not only be represented by numbers, but the IDSS should incorporate a large variety of representation and visualisation (maps as first choice, but also tables, graphs and indicators) tools; this concept is even more important for people and non-expert stakeholders, in order to show the effects and consequences of flood events, but also to show why some areas could be used as retention areas an others not.

The IDSS should also provide information with a balanced multi sectoral point of view, this is very important in case of hard conflicts; because if stakeholders feel that the system is based on a balanced scheme, they can feel that also their interests are considered and the public acceptance can be improved.

[4] R: Requirement
[5] O: Objective

As it has already been mentioned the IDSS should support the user in the discussion phase of the DMP, as a consequence the IDSS could be directly used during meetings between decision makers, their consultants and the stakeholders. Once again as stated in the previous section differences emerge in developing the system like a “discussion facilitator” or an analysis tool.

Finally the IDSS should give information in particular regarding benefits linked to nature oriented flood damage prevention measures, in order to “promote” them. This could be useful not only during the planning process, but also as far as the acceptance of directives impositions and building ban in flood plains are concerned.

In table 3.2 the results regarding the model calculations functionality are showed.

The first requirement is the input and storage of existing data; that is a natural requirement for model calculations, but handling integrated planning problems also signifies input and above all storage of a great amount of different type of data; in particular land use data seem to be necessary.

The second requirement refers to the input for the models of a large variety of measures, variants and scenarios (for the definitions of these terms refer to the glossary). Together with all typical flood damage prevention technical solutions (like construction of dykes and dams), the focus has to be pointed on nature-oriented flood damage prevention measures and variants, as already stated in section 1.3, they have to be considered as the first possibility. In the appendices, a list of such measures found in these documents is provided. The main concept is once again summarized by the fact that restoring the natural old river state, by providing the river with more room for its natural expansion will ameliorate the status of the three layers considered in nofdp project.

According to these documents also some calculations on future scenarios have to be integrated, where scenario refers to the changes in external parameters, like for example climate changes, population grow and land use changes.

Some documents underline that proposals can also arise from the stakeholders group, that could be good implemented in the system by means of an internet forum, where also people can make proposals; we will see how in the actual definition of the nofdp IDSS structure such a kind of forum is foreseen.

The definition of the scale resolution is a key factor not only for the profile of requirements, but for the whole IDSS development. The problem is that an IDSS contains different types of models with different temporal and spatial scales.

Table 3.2: Synthesis of requirements and objectives for the model calculations functionality (nofdp project developments)

Synthesis for the model calculations functionality-nofdp project developments
R: Input and storage of a great amount of existing data O: Handle the integrated view of nofdp
R: The input of model calculations is a large variety of nature oriented flood damage prevention measures, variants and scenarios regarding small and medium size river basins; some more technical measures have also to be integrated O: Evaluate proposals coming from the users of the system
R: Flexibility in scales resolution: river basin level=low resolution + measure level=high resolution O: Low resolution for global planning, assessing effects of flood damage prevention measures upstream and downstream, no political boundaries (see EU WFD) and high resolution, for local effects of measures on vegetation and ecology
R: A good integrated model base or integrated post evaluation of single models outputs O: Forecast the future status of the three layers (water, human, ecology)
R: Flood risk and flood frequency O: Integrate the water board flood prevention targets
R: Indication of uncertainty in models calculations O: Evaluate the reliability of models results
R: The IDSS model base should contain open source, widely used, coupled models with an open interface structure (no demand for real time), essential is the link with the GIS O: Wider distribution of the IDSS

The best solution seems to be the flexibility in scale resolution, that is to say to have the possibility of modelling from coarse to fine. In particular the reference point should always be the river basin, that implies no political boundaries and a transnational approach.

In any case a great boundary in the definition of scale resolution is the availability of data.

The IDSS should provide the user with a kind of integrated forecasting, in order consider the future status of the three layers. For this reason the IDSS should either contain an integrated model base with coupled model or develop a kind of integrated post-evaluation, that is to say the integrated view is provided in a second step and the models work independently.

Obvious requirement for the nofdp IDSS is the determination of flood risk and flood frequency; in particular considering water boards (designed end users of the system for this thesis) flood damage prevention targets (see for example water board Mümling 1/50 years flood prevention objective).

The uncertainty in the model results in order to asses the reliability of these results, is a fundamental requirement in order to trust the system output.

Finally some technical requirements regard the fact that in the nofdp IDSS it will be no demand for real time control; moreover the models should be open source (that means no additional costs), preferably widely used (the user can have no time and resources to learn using something totally new) and they have to be plugged in the IDSS with an open interface structure, that is to say the user can plug in his models.

In table 3.3 the results for the toolbox functionality are provided.

Table 3.3: Synthesis of requirements and objectives for the toolbox functionality (nofdp project developments)

Synthesis for the toolbox functionality-nofdp project developments
R: The IDSS should provide the user with a selection of most relevant information regarding nature oriented flood damage prevention alternatives O: Reduce the complexity of a great amount of knowledge
R: Generation of new information by overlapping them on the local and regional level O: Put together different visions of the problem and show the effects of this overlap

The first requirement refers to the concept of Reduction and Check, because handling problems in an integrated way implies a great deal of information, knowledge and data to manage; that is why there is the necessity to reduce them emphasising the most important one.

For example it is important to extract all relevant information from documents such as directives focusing on the theme of nature oriented flood damage prevention, in order to reduce the dispersion of relevant information. This requirement is also important for the other product developed by nofdp project: the knowledge base (refer to section 2.7).

This requirement can be implemented by creating for example nature oriented flood damage prevention guidelines or thematic check lists (in order to check if something is missing in the planning process).

The second requirement is linked to the idea of overlapping information in order to create new information, that is to say the IDSS should not provide the user only with model calculations, but it has to generate new information by overlapping them.

This operation is useful in order to put together different views of the problem and to show which are the consequences of this combined vision.

Finally In table 3.4 the results for the evaluation functionality are provided.

Table 3.4: Synthesis of requirements and objectives for the evaluation functionality (nofdp project developments)

Synthesis for the evaluation functionality-nofdp project developments
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare different planning alternatives and weigh different interests arising from an integrated planning approach
R: Optimisation function O: Make optimum decisions
R: Assess the monetary benefits of nature oriented flood damage prevention and monetary compensations for the inundated land O: Give a monetary value to nofdp, underlining the monetary benefits and calculating the costs

The first requirement concern the evaluation, the comparison and the weighting of alternatives, for this reason the IDSS should incorporate a multi-sectoral and multi-objective evaluation scheme in order to weight the results coming from model calculations, because as already mentioned only model outputs are normally not sufficient to support the user.

The IDSS could be also equipped with some kind of optimisation tool (e.g. multi-criteria analysis). As mentioned in section 3.3.2 the prioritizing of the IDSS functionalities will also influence this requirement, because if the accent will be posed on the communication functionality this requirement will be less considered, because such kind of optimisation tool could result less understandable if applied in a participatory context; on the contrary such a kind of requirement could be well integrated in the nofdp IDSS if the system will be developed like an analysis tool.

Finally the last requirement is linked to the cost/benefit analysis and in particular from one hand the system have to provide the user with economical information about the benefits of nature oriented flood damage prevention (e. g. more natural areas signifies more retention volume) and on the other side the system should make economical calculations for example on compensation payments for the inundated land.

3.3.4 Analysis of potential users interviews

Second step in the construction of the profile of functionalities and requirements is the analysis of the interview with potential users of the system. As it has already been mentioned, due to uncertainties on the definition of potential users of the nofdp IDSS, the project partners decided to carry out some interviews; the complete list of interviewed people is provided in appendices, with also a copy of the questionnaire, which we have developed for these interviews.

In accordance with the transboundary dimension of nofdp project, the interviews are carried out in three different countries (Germany, the Netherlands and Belgium) and if from one side the integration of information from different countries represents an added value, from the other side some differences in how water is managed clearly emerge.

Moreover the interviewed people work at different steps in the DMP, because the first purpose of these interviews was to have a better idea on who are the potential users of the

system; for this reason according to the hypothesis made in section 3.2 requirements, which don't reflect this conception will be less considered (e.g. interview to O. Gieseler, decision authority with a quite structured kind of work).
In table 3.5 the synthesis of the analysis for the communication functionality is provided for the reader.

Table 3.5: Synthesis of requirements and objectives for the communication functionality (potential users interviews)

Synthesis for the communication functionality-potential users interviews
R: The user should have the possibility to understand the output of the IDSS (e.g. symbols on maps, glossary functions etc.) and how it is generated (no black box system); when not enough the system has to be spilt up in many parts / different user interfaces for different users (in particular most of the time the model base will be operated by external consultants) O: Provide the user with as much transparency as possible and improve the mutual understanding in an inhomogeneous group of experts
R: The user interface of the IDSS should be self explaining O: Provide the user with as much user-friendliness as possible
R: The IDSS should support the user in preparing concept plans for the administrative level O: Be an intermediary in the iterative and interactive process between the technical and the administrative level
R: the IDSS should present its information in a comprehensible and balanced way O: Inform citizens and communities in order to solve conflicts arising in the planning process (in particular regarding the spatial planning)
R: The IDSS should be equipped of visualisation instruments (visualisations, pictures, aerial photos etc.) O: Visualize the model output and make it more comprehensible

The first requirement has already been mentioned and it refers to the concept of transparency, what it emerges is that models are most of the times operated by external consultants, which underlines the fact that the IDSS model base should be operated by experts. As in this case, we will see that many requirements are repeated in all the three parts of the analysis; it is important in a first phase to repeat them, because the objective of this section is to analyse the four components of the concept as independent, in order to have a picture of these different points of view and put them together in a later step.
Linked to the transparency of the system and of the model output, there is the concept of an easy self-explaining user interface, because even though the nofdp IDSS users will be experts, the user-friendliness is always a vital task for the system.
Finally the last three requirements are closely linked to the possibility of using the nofdp IDSS in participatory contexts, where the system could help the user in preparing a kind of "vision" on which the administrative level has to decide, but at the same time support the information for the public, providing balanced information and using a great deal of visualisation (as a first choice).

The results for the model calculations functionality are listed in table 3.6.

Table 3.6: Synthesis of requirements and objectives for the model calculations functionality (potential users interviews)

Synthesis for the model calculations functionality-potential users interviews
R: Input of a great amount of existing data and possible link with other interesting data base(e.g. Retentionskataster,nature protected areas etc.) O: Handle the integrated view of nofdp
R: The input of model calculations is a large variety of nature-oriented flood damage prevention measures, variants and scenario some more technical measures have also to be integrated O: Evaluate proposals coming from the user of the system
R: Flexibility in scales resolution: project level=local scale and plan level=regional scale O: Consider in particular a larger scale as the project scale in order to have no problems out of the area affected by the project
R: A good integrated model base or integrated post evaluation of single models outputs O: Forecast the future status of the three layers (water, human, ecology)
R: Flood risk and calculations on volumes in case of floodings and with retention areas O: It's a natural requirement of flood prevention
R: The IDSS should be linked with GIS O: Good management of spatial information

Here any new comments can be added, because the requirements are the same of the previous section; this is also a good result, because that implies that two parts of the analysis are in accordance regarding the model calculations functionality.

Next synthesis regards the toolbox functionality (table 3.7).

Table 3.7: Synthesis of requirements and objectives for the toolbox functionality (potential users interviews)

Synthesis for the toolbox functionality-potential users interviews
R: Reduce information in form of thematical check lists and guidelines O: Supporting the user reducing a great deal of information
R: Generation of new information by overlapping them for example in form of maps with different layers O: Identify and localise conflicts (e.g. dangers in case of flooding of abandoned polluted areas) or visualize new alternatives

The two listed requirements are always linked to the concepts of reduction and overlap of information, in particular by means of check lists and guidelines (as far as the reduction is concerned) and maps with different layers (for overlap), in particular overlapping information is recognized as useful for the localisation of conflicts.

Finally table 3.8 reports the results for the evaluation functionality.

Table 3.8: Synthesis of requirements and objectives for the evaluation functionality (potential users interviews)

Synthesis for the evaluation functionality-potential users interviews
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare different planning alternatives and weigh different interests, more attention has to be posed on spatial planning conflicts as on ecology
R: Optimisation function O: Make optimum decisions in flood damage prevention planning
R: Assess the monetary aspects of prevention of flood events (ex. Costs of measures and compensation payments) O: Introduce the monetary aspect in the evaluation process (give monetary value to nofdp)
R: Systematisation of alternatives by means of classification O: Categorize, group and rank alternatives

Once again an integrated planning approach gives the urgency of multi sectoral and multi objective evaluation tools, but an interesting outcome of the potential users interviews is that the attention during the evaluation should be more posed on conflicts between flood prevention and spatial planning issues than on ecology.

A new kind of requirement refers to the classification of alternatives, as an example the user could be interested in knowing which of the selected alternatives is the most nature-friendly or the best one under an economical point of view.

Finally during the Internal Workshop in the month of march project partners extract some further relevant comments about these interviews; first of all the fact that most of the interviewed people prepare proposals and the end decisions are made at an higher level in a iterative process, in such a kind of working mechanism a DSS could be well integrated.

Secondly, particularly worthwhile is the interview with the consultancy office (because as stated in section 3.2 also external consultants are nofdp IDSS potential end users), where what emerges is the need for some kind of visualisation tool more than calculations (they already make calculations by their own).

Finally the project partners agree on the fact that interviews are very good to extract requirements for the system and they have to be continued.

3.3.5 Analysis of Internal Workshop role plays

This part of the analysis includes the four role plays, which were carried out in the month of March during the Internal Workshop. As it has already been underlined the reports of these simulated decision-making situations is also very valuable, in order to have a wider impression of all the actors involved and of course of their needs.

In the appendices a complete version of the texts for these four role plays is enclosed.

Results for the communication functionality are in table 3.9.

All the four role plays simulate a working meeting where, the most important actors of the discussion phase of the DMP (political authorities, policy makers, project leaders, nature organisations, farmers, inhabitants, town developers, etc.) have to discuss about different alternatives, which could be implemented.

Table 3.9: Synthesis of requirements and objectives for the communication functionality (Internal Workshop role plays)

Synthesis for the communication functionality-Internal Workshop role plays
R: The end user should have the possibility to understand the outputs of the model base, a too detailed system diagram is to be avoided, when not enough the system has to be spilt in many parts / different user interfaces for different users O: Avoid a black box system and try to provide the user with as much transparency as possible
R: The IDSS should be equipped of visualisation instruments (maps etc.) O: Try to visualize the model output in order to answer to questions like what for areas are interested, what are the effects and why not somewhere else
R: The IDSS should help the user in preparing concept plans, that is to say prepare some of the information on which the administrative level has to make a decision O: Be an intermediary in the iterative process between the technical and the administrative level
R: the IDSS should present its information in a comprehensible and balanced way O: Inform citizens and communities and the large amount of stakeholders involved
R: The IDSS should support the discussion phase of the DMP O: Use the IDSS in meetings where decision makers and their consultants have to discuss on different alternatives with the stakeholders involved
R: The system itself should act like a bridge between different type of knowledge O: Try to compensate to the lack of common language existing between an inhomogeneous group of experts

Once again the theme of transparency, visualisation of model output, preparation of visions for the administrative level, information for the public, support for the discussion phase of the DMP are mentioned again and moreover these simulations show that the system should act like a bridge between different knowledge, compensating the great lack of common language between different experts (due to the past sectoral approach).

Model calculations requirements are reported in table 3.10.

Table 3.10: Synthesis of requirements and objectives for the model calculations functionality (Internal Workshop role plays)

Synthesis for the model calculations functionality-Internal Workshop role plays
R: Input of a great amount of existing data, a good data and information base is requested (in particular GIS data!) O: Handle the integrated view of nofdp
R: Possible input of a large amount of measures, variants and scenarios (particular attention has to be posed on nature oriented alternatives) O: Evaluate proposals coming from the users of the DSS and the stakeholders involved
R: Flexibility in scales resolution: the attention was posed on transnational level and catchment scale O: Consider a larger scale as the project scale in order to have no problems with other cities out of the project area

R: A good integrated model base or integrated post evaluation of single models outputs O: Forecast the future status of the three layers (water, human, ecology)
R: Flood risk and calculation on different flood events O: It's a natural requirement of flood prevention
R: Indication of uncertainty in models calculations O: Evaluate the reliability of models results
R:Technical requirement for the IDSS should be the link with GIS O: Good management of spatial information
R: The system should have the possibility to make calculation again and present them in little time O: Spare time in the iterative process occurring in the planning process

Also the requirements of model calculations are in accordance with the previous analysed documents; what is new is the fact that the system should react quickly in making calculations again, if one of the objectives is to spare time in the iterative planning process. Results of the toolbox functionality are given in table 3.11.

Once again to reduce information is realized by means of check lists and guidelines in particular regarding the legal restrictions; the overlap of information finds application in particular regarding spatial potentials, which means to define for every area, which are the possibilities and the potentialities regarding its use.

Table 3.11: Synthesis of requirements and objectives for the toolbox functionality (Internal Workshop role plays)

Synthesis for the toolbox functionality-Internal Workshop role plays
R: Reduce information in form of thematical check lists and guidelines O: Support the user reducing a great deal of information he has to deal with in particular concerning legal restrictions
R: Generation of new information by overlapping them for example in form of maps O: Identify and localise conflicts, affected areas and above all spatial potentials (areas suitable for a certain kind of use)

Finally the requirements of the evaluation functionality are indicated in table 3.12.

Also in this case all the requirements concern the weighting of alternatives and the cost/benefit analysis. It is important to underline that once again ecology take the connotation of a social aspect (it is translated in requirements like visual impact, landscape value, recreational value) and it get importance in a later phase in the planning process.

In any case the partners of the investment projects comment that the simulations were quite realistic and for this reason also the analysis of these documents can be considered useful for the profile of requirements.

Table 3.12: Synthesis of requirements and objectives for the evaluation functionality (Internal Workshop role plays)

Synthesis for the evaluation functionality-Internal Workshop role plays
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare and weigh and show why an alternative; more attention has to be posed on spatial planning as on ecology; ecology is intended like visual impact, landscape value, recreational value, eutrofication problems, it get importance in a later stage.
R: Assess the monetary aspect of prevetion flood events (ex. costs of measures and compensation payment in particular for farmers) O: Introduce the monetary aspect in the evaluation process (give monetary value to nofdp)

3.3.6 Analysis of some relevant policy documents

Last step in the definition of the profile of requirements and functionalities is the analysis of some policy documents, judged important for the problem context faced by nofdp.
As it has already been mentioned this part is quite important, because of the future perspective provided by such documents.
Unfortunately there is little time left for this section and only some general comments will be added, keeping in mind the requirements of the previous sections and trying to understand if they are compatible with these sources.
Reasons for such an analysis is the fact that during potential end user interviews and several working meetings, many interviewed people and project partners have recognized the increasing importance of for example European directives and although for example the European Water Framework Directive is not at the moment totally implemented in national and local legislation, many of them recognize the future importance of such documents.
The analysed sources are:

- European Water Framework Directive (2000/60/EC)
- Document of the European Commission on the “Flood action programme”

The first analysed document is the European Water Framework Directive (2000/60/EC); it is analysed as the first one, because of its strategic importance.
The EU WFD came into force in December 2000 and its principles had to be transposed into national laws by December 2003; but the achievement of its objectives have a longer timetable, because it will meet its environmental objectives (synthesized by the statement

"good ecological status for all European water") by 2015 and the final deadline for meeting all the objectives is foreseen for 2027; as a consequence we can easily understand that a directive with such a long time for its implementation will introduce a lot of strong changes in how water is managed.

Unfortunately many water managers regret that the directive doesn't clearly address floods and there is not a clear idea on how to implement it, but as all the interviews with potential end users have underlined, they all recognize its future importance; for this reason in table 3.13 a list of aspects to consider in the construction of the profile of requirements are listed.

Regarding the communication functionality, we find a strong accent on a participatory kind of planning process, where the public should be actively involved and eventually have access to the information used for the drafting of the river basin managements plans; in both cases the nofdp IDSS could be useful for its ability to represent information in a more comprehensible way.

Table 3.13: EU WFD relevant requirements regarding the profile of functionalities for the nofdp IDSS

EU WFD relevant requirements regarding the nofdp IDSS concept
COMMUNICATION
Active involvement of the pubblic
Access given to background documents and information for the development of river basin management plans
MODEL CALCULATIONS
Maps with the locations of protected areas
River basin as the starting point/transnational dimension, but also emphasis on local level
All surface waters and groundwater in a good quality
Consider measures which protect, enhance and restore the status of acquatic ecosystem
TOOLBOX
Impact of human activity on the status of surface water and groundwater
Prevent and reduce the impact of accident pollution incidents as a result of floods
EVALUATION
Economic benefits of protection of water status
Costs of measures to achieve good water status
The ecological quality refers to the values of the biological quality elements

As far as the model calculations functionality is concerned, the IDSS could be useful for its data and information base, where also maps with protected areas could be stored.

The emphasis on the catchment level and the input of measures which have to protect, restore and enhance the water body have already been mentioned many times in the previous sections.

The new aspect strongly underlined by the directive is the accent on the water quality, because the EU WFD is mostly focused on water quality and water quantity is an ancillary element.

Regarding the toolbox functionality some support could be provided by the IDSS overlapping the information of human activities on the water layers (particular attention should be posed on accident pollution incidents as a result of floods).

Finally as far as the evaluation functionality is concerned, we can find in the directive some notions to the evaluation of benefits and cost for measures in order to reach a good water status. It has also to be underlined that the ecological quality in the directive refers to the quality of the biological elements (that is the notion of ecology in the EU WFD).

Summing up it can be observed that even though the directive point its attention on an integrated river basin management (this aspect is in accordance with the three layers approach of nofdp project), the attention is mostly posed on water quality and floods event are not directly addressed.

For this reason the second part of this section analyse a document of the European Commission on the future “Flood action programme”; the new legislative proposal of the European Commission in order to address flood events and try to remediate to the gap of the EU WFD on this theme.

In table 3.14 the list of aspects of this programme thinking about the nofpd IDSS is provided.

As far as the communication functionality is concerned, also this programme underlines the necessity of a participatory planning context, where information should be available for people and authorities; in particular flood mapping could increase well the level of comprehension.

For the model calculations functionality, it could be found another time the concepts of transboundary dimension, input of current and future scenarios, input of nature-oriented flood damage prevention measures (e.g. floodplain restoration), and the concept of uncertainties in models calculations, which could find reflections drafting the flood maps.

To the toolbox functionality could be associated the concept of reducing relevant EU environmental legislation and finally to the functionality of evaluation it can be associated the assessment of risk of floods to people, propriety and environment and of course the costs of risk management measures.

Once again also in this programme it can be found the idea of implementing an integrated holistic approach against flood risk and the nofdp IDSS could well support some of the requirements listed in the previous table.

Table 3.14: Flood action programme relevant requirements regarding the profile of functionalities for the nofdp IDSS

Flood action programme relevant requirements regardng the nofdp IDSS concept
COMMUNICATION
Information on flood risk and its effects available to the public and relevant authorities
Flood mapping increasing the public awareness of the areas where floods can occur
MODEL CALCULATIONS
Necessary coordination upstream-downstream/transboundary dimension
Addressing the current situation and if appropriate scenarios for future flood risks (climate changes and changes in land use)
Information about natural floodplain storage areas serving as retention area
Uncertainties in drafting flood maps
TOOLBOX
Drafting flood risk management plans relevant EU environmental legislation has to be taken into account
EVALUATION
Indicate how flood risk varies in terms of economical damages, potential people at risk and adverse consequences for the environment
Costs of flood risk managements measures

At the end of the analysis one can comment on the fact that the collected information are too much and to make a summary of them is not easy; fortunately the four analysed section seems in agreement and most of the time we find recurring requirements.

In any case a prioritizing of most important functionalities and requirements has to be done and we will see how in chapter four this thesis try to accomplish to this task.

3.4 Feasibility of profile of functionalities and requirements for the nofdp IDSS

After the end of the analysis, which provides a profile of functionalities and requirements for the nofdp IDSS now some comments have to be added, in order to understand what are the next steps in order to understand to what extent such a conception is feasible.

For this reason in section 3.4.1 some general comments on the nofdp IDSS structure are added.

3.4.1 Technical feasibility

Analysing the project development documents the structure provided in figure 3.2 was found as last official structure of the nofdp IDSS, for this motives some comments are added in order to understand if such a system structure is in accordance with the profile of functionalities and requirements extracted in the previous sections.

The first comment can be made on the fact that the structure is divided in two parts, the expert system and the public DSS, that means that only experts will operate the model base, but at the same time the public can make proposals by means of a kind of Internet forum; the two systems are quite similar, but the Internet forum will obviously constitute a kind of simplification of the real modelling system; for this motive this structure seems to be in accordance with the mentioned necessity of transparency of the system and with the fact that the IDSS should be divided into expert system and non expert system.

Secondly we also find a general kind of specification of models contained in the model base; we can observe that the vegetational models could be used for all the requirements regarding the input of mostly nature-oriented flood damage prevention alternatives.

Also the cost-benefit analysis and the need for spatial information find a reflection in the derived top-down concept.

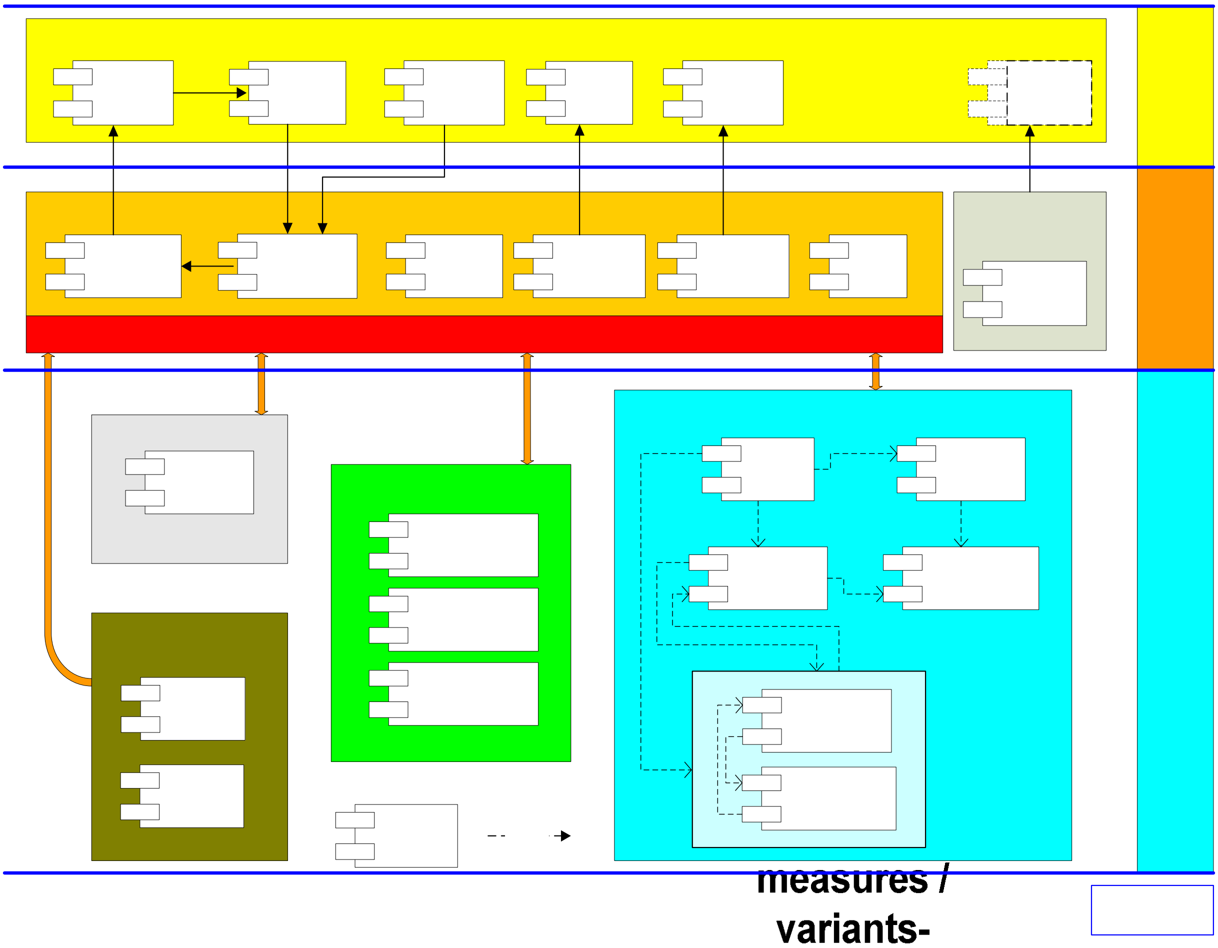
Finally also some other components like scenario development, variant development and map viewer seems to accomplish well to requirements like input of scenario and measures, but above all the great need of visualisation and presentation tool.

In any case it is very difficult to confront the derived concept of the thesis with this general structure. It is also difficult to compare this work with the results of a bottom up study operated on the nofdp IDSS (Van Dijk, E. (2004)), because the information of these study are focused to the structure of the model base, while this work provide information on the whole structure of the DSS.

For this reason in order to try to make some conclusions on the developed concept another kind of prioritizing of requirements is needed, which points not only on technical aspects.

In chapter four we will see how this Thesis manages in testing the concept.

Figure 3.2: Project partners nofdp IDSS developed System structure.



4 Presentation of the IDSS defined concept to the nofdp investment project “Retention area Zell/Water board Mümling”

After giving a proposal for the profile of requirements and functionalities, a kind of test is requested. Unfortunately as it has already been mentioned, to the fact that the derived information are still general and for that reason a direct comparison with the bottom-up technique results is not possible.

After some literature research it becomes clearer that in such situations a good method of give priorities to the requirements is represented by a methodology called MoSCoW, where this word stands for:

- M-Must have this requirement
- S-Should have this requirement
- C-Could have this requirement
- W-Wont’t have requirement (but perhaps in the future?)

For this reason a kind of prioritizing of requirements (similar, but simpler as the MoSCoW methodology) is effectuated during an interview with Ing. Matthias Sottong working at the water board Mümling, commented in section 4.1.

4.1 Analysis of the interview with Ing. Matthias Sottong working at the water board Mümling

As stated before an interview with Herr Sottong was carried out in order to test the conceptual developed scheme and try to give some priorities to it.

The complete questionnaire with Herr Sottong answers is provided in the appendices.

The MoSCoW method was made simpler, in order to improve the comprehensibility of the questionnaire; moreover the requirements extracted in chapter three were translated in a more tangible and operative way, because Herr Sottong is an engineer, working at a water board, for this reason he is not interested in any theory, but in more concrete and tangible requirements.

As we can see from the results, Herr Sottong points a lot of attention on the communication functionality, giving a value of “important” to the transparency requirements and “very important” to the requirement of showing the result to the stakeholder group in the presentation requirements; always in the communication functionality, the requirements, which doesn't interest him are a too detailed system analysis, in order to give answers to specific questions, the promotion of benefits linked with nofdp measures and the picture of vegetation, changing with time.

As far as the model calculations functionality is concerned he is very interested in the local scale (project level) and he is not interested in non-structural measures (e.g. naturalistic engineering), scenarios, ground water calculations and the link with other database (like "the Hessian cadastre of retention area").

In the toolbox functionality, he appreciates the idea of reduction of information and he makes a proposal for a missing requirement, to use the nofp IDSS in projects management, receiving support by means of check list, that help the project manager not to forget something important. For the overlap of information he recognizes as only requirement the maps overlay.

Finally as far as the evaluation functionality is concerned he is interested in all the items, a part from the requirements regarding the optimisation; they can be used for internal use in the water board, but not for the communication.

The complete result can be seen in the appendices.

Other general comments that he adds are linked with the concept of system flexibility, that is to say the system should grow up with the users, in order to incorporate new arising needs; moreover for him it is important to enter some questions in order to learn about the problem, it is almost like to find new ideas with the system, he wants to use the system in an explorative way.

A modular structure will be preferred in order to skip something, which doesn't interest him and once again he underlines the necessity to divide the system in expert system and non expert system.

The transparency (in particular to have insight in the models parameters and so on) is important for him only in case he operates the model base.

He strongly underlines the need of visualisation tools in order to better and easier communicate with people (he made a simple clear example: to show people water levels linked with house pictures).

For the theme of best practice example, he comments that for him the best way is a kind of internet forum, where one can be inspired from other good examples.

The idea of alternative classification is not so good for him, because he is not interested in an alternative, which has for example only economical advantages.

As overall conclusion he is very interested in the IDSS visualisation capabilities, but he is not so much interested on how they are generated; moreover he distinguishes between the presentation of the problem and the presentation of the solution.

In any case he commented that any particular relevant functionality or requirement is missing in this schematisation, and that was quite a good result for the author of this thesis.

5 Conclusions

The most important conclusions and results of this work are listed below:

- The problem context faced by the nofdp IDSS was too general and unclear in the initial phase, it had to be defined.
- The field of competence of a DSS in the DMP was defined (Planning process and Discussion phase).
- A DSS seems to be a good solution for nofdp project objectives.
- A top down approach in order to define the profile of functionalities and requirements was carried out, but a lack of a clear definition of end users make necessary the shift towards IDSS functionalities.
- A kind of prioritizing of the most important functionalities and requirements was not possible with the results of the bottom up approach, for this reason the concept was tested by means of an interview with a potential end user.
- A prototype approach has to be carried out with the investment projects group

The most important open questions remain:

- Better definition of potential users of the system
- Prioritizing of functionalities (decide for what purpose the nofdp IDSS should be implemented)

References

Bundesanstalt für Gewässerkunde (BfG): *Decision Support Systems (DSS) for river basin management*, International workshop on 6 April 2000 in Koblenz.– Veranstaltungen, Heft 4/2000. Koblenz - Berlin.

Council Directive 92/43/EEC of 22 May 1992 on the consevation of natural habitats and of wild fauna and flora.

De Kok, J.L.; Wind, H.G.; van Delden, H.; Verbeek, M. (2000): *System diagram for river-basin management and first results from feedback with Elbe Ökologie and Elbe 2000*, Heft 4/2000. Koblenz - Berlin.

De Kok, J.L.; Wind H.G. (2003): *Design and application of decision-support systems for integrated water management: lessons to be learnt*, Physics and Chemistry of the Earth 28 (2003), p.571-578.

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Engelen, G. (2000): *The wadBOS Policy Support System: Information Technology to bridge Knowledge and choice*, Technical paper prepared for National Institute for Costal and Marine Management/ RIKS/ Directorate-General of Public Works and Water Management/ Ministry of Transport, Public Works and Water Management.

Hahn, B.; Engelen, G. (2000): *Concepts of DSS systems*, BfG Veranstaltungen, Heft 4/2000, Koblenz - Berlin.

Hemmati, M. (2002): *Multi-stakeholder Processes for Governance and Sustainability: Beyond Deadlock and Conflict*, Erthscan Publications, London.

Internationale Kommission zum Schutze ds Rheins (IKSR) (1995): *Grundlagen und Strategie zum Aktionsplan Hochwasser*, Koblenz.

Kofalk, S.; Kühlborn, J.; Gruber, B.; Uebelman, B.; Hüsing,V. (2001*): Machbarkeitsstudie zum Aufbau eines Decision Support System (DSS). Zusammenfassung des im Auftrag des BfG erstellen Berichts "Towards a Generic Tool for river Basin Management-feasibility study-"*, Bfg projektgruppe Elbe Ökologie (Hrsg.): Mitteilung Nr.8. Koblenz-Berlin.

Lammel, B. (2002): *Managing floods in Europe: The answers already exist. More intelligent river basin management using wetlands can alleviate future flooding events*, WWF Background Briefing. Paper 26.

Marakas, G. M. (1999): *Decision Support System in the 21st Century*, Upper Saddle River, New Jersey: Prentice-Hall.

nofdp (nature oriented flood damage prevention) project website under: http://www.nofdp.net/ (state 31/7/2005).

ICPR (International Commission for the Protection of the Rhine) (2001): *Rhine 2020-Programme on the sustainable development of the Rhine, Conference of Rhine Ministers 2001*, Koblenz.

Schielen, R. M. J. (2000): *Recent History and Future Developments of Decision Support System for the Dutch Rivers*, Heft 4/2000. Koblenz - Berlin.

Schneidergruber, M.; Cierna, M.; Jones, T. (2004): *Living with foods: Achieving ecologically sustainable flood management in Europe*, WWF Policy Briefing.

Simon, H. A. (1960): *The new science of management decision*, New York: Harper & Row.

United Nations Department of Economic and Social Affairs Division for Sustainable Development website under: http://www.un.org/esa/sustdev/ (state 31/7/2005).

Van der Most, H.; Gijsbers, P.; Dijkman, J.: *Flood Managment along the River Rhine: Decision Support Systems in a Participatory Context.*

Van der Sar, A.; Bloech, H. (2005): *Flood action programme,* document of the European Commission for the meeting of Water Directors on 21/22 July 2005.

Van Dijk, E. (2004): *Selections of models for the development of the Information and Decision Support System (IDSS) for the EU-Interreg-IIIB-Project: nature oriented flood damage prevention*, BfG-JAP-Nr.:3118.

Westphal, K. (2005): *DSS: A comprehensive Water Resources Management Tool and Decision Process*, under www.CDM.com Expert Interview Archive.

Winterscheid, A.; Ostrowski, M.; van Gulik, S.; Lambregts, R.; de Low, R.; Slikker, J.; Fuchs, E.; Hüsing, V. (2004): *nature-oriented flood damage prevention (nofdp): A project overview.*

Zuiderent, R. (2003): *Water, Climate and Risk Management-how the Dutch are dealing with climate changes. Summary of the "Dutch Dialogue on Climate and Water" Report.*

Glossary

Alternative	Generic expression indicating the subject on which the IDSS has to make its evaluation; Alternatives can be represented by a measure, a group of measures: a variant or a scenario
Boundary rationality	It refers to the fact that the best solution is most of the time out of the search space and for this reason impossible to reach (Simon 1960)
Data base	DSS system component where the various activities associated with retrieval, storage and organisation of the relevant data for the particular decision context are managed (Marakas 1999)
Data-oriented DSS	DSS focused primary on data retrieval and analysis support activities (Marakas 1999)
Decision maker	Person in charge of taking a decision based, in whole or in part, upon the output of a DSS (Marakas 1999)
Decision-Making Process (DMP)	Process trough which decisions are taken
Decision Support System (DSS)	Computerized information systems that support decision-making activities
Eco-hydrological model	In the project, model capable of forecasting the effects of flood events on the ecological system
Effectiveness of a decision outcome	The existing gap between the theoretical optimum decision and the decision that will be made
End User	Person, who directly interacts, operate and communicate with the DSS
Floodplains	The low-lying areas of land adjacent to rivers, that are periodically inundated with water (Schneidergruber et al. 2004)
Functionality	A system functionality can be seen like a kind of “box” containing many similar requirements expressing the same need
Information and Decision Support System (IDSS)	Decision Support System that contains information not only in form of numerical data, but also in form of text documents (e.g. directives, guidelines, best practice examples, etc.); in the text it refers to nofdp IDSS
Knowledge Base	DSS system component where the “knowledge” of the DSS is stored; knowledge here refers to rules, heuristics, boundaries, constraints and any other “knowledge” that has been programmed in

	the DSS by its designer (Marakas 1999)
Measure	Local interventions in the river system, defined by its type, its location and specific parameter values (project partners official definition)
Messy problems	Problems whose objectives are conflicting and for which the solution is not simple or evident
Model	Simplification of some event or process constructed for the purpose of studying that event and thus developing a better understanding of it (Marakas 1999)
Model base	DSS system component that contains all the specific domain models necessary to the problem environment
Model-oriented DSS	DSS including activities such as simulation, maximizing or optimizing scenarios (Marakas 1999)
Multifunctional land use	Refers to the concept that the land used for flood prevention can also be used for other purposes (agriculture, recreation, nature)
nature-oriented flood damage prevention (nofdp)	It refers to the name of the project or to the new vision introduced by it
Objective	It refers to the reason why a requirement should be implemented into the system
Potential end user	Person or people that in a preliminary phase of a project is design to be a probable user of the system, he directly interacts with it
Reasoning	Process by which a new information is derived from a combination of existing or previous derived information (Marakas 1999)
Requirement	Expressed wish on the system distilled by different documents (ex. potential end user interviews, project protocols, etc.)
Role play	simulation of a typical decision making situation where a DSS could be used, in order to observe the needs and wishes of the actors involved
Scenario	External boundary conditions (e.g. temperature, rainfall) applied in the (hydrologic or ecologic) assessment (project partners official definition)
Spatial planning	Complex of regulations and methods used by public authorities to influence the distribution of people and activities in spaces of various scales. This includes urban, regional, national and international

	levels
Sustainable development	Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs (from: United Nation Division for Sustainable Development)
Stakeholder	In the nofdp problem context, it refers to local communities, nature organisations, farmers and all other users of the area, where measures have to be implemented.
System	General concept used to indicate the IDSS in its complex
Three layers approach	It refers to the idea of nofdp project of considering the river system like the result of three overlapping layers (water, ecological and human system)
Tool base	DSS system component incorporating tools to describe, compare, present, rank and evaluate the different alternatives
User	Person or people, responsible for providing a solution to the problem at a hand or for making a decision within the context the DSS was designed to support (Marakas 1999)
Variant	A group of measures, also called landscape planning ‘strategy’ or ‘alternative’ (project partners official definition)
Water board	Authority concerned with water management of an entire river basin or part of it

List of abbreviations

BfG	German Federal Institute of Hydrology (Bundesanstalt für Gewässerkunde)
DMP	Decision-Making Process
DSS	Decision Support System
EU WFD	European Water Framework Directive (2000/60/EC)
GIS	Geographic Information System
GUI	Graphical User Interface
IDSS	Information and Decision Support System
IRBM	Integrated River Basin Management
nofdp	nature-oriented flood damage prevention
NEW	North West Europe
RKH	Retentionkataster Hessen

Appendices

Contents of appendices

Appendix A: Questionnaire for the potential users interviews

A General section

1. Name, organisation and profession
2. What is the aim of your organisation?
3. What are your areas of competence (professional knowledge) and decision (position in the decision making process)?
4. Which are the main conflicts that you see in your work between flood protection, spatial planning and ecology and how do you solve it?

B Planning alternatives section

1. Do you regularly experience the need to consider and develop planning alternatives?
2. Which planning alternatives (measures / scenarios / see also global change scenarios) are important for you and which planning alternatives (measures / scenarios) are frequently used in your work?
3. Who develops these planning alternatives, external councillors or not?
4. Is it important for you to consider different scales?

C National and European laws section

1. Do EU directives and laws play a role in your decisions / planning?
2. Are EU directives and laws already implemented in those national laws authoritative for your decisions / planning?
3. Which do play an important role in the plan process?

D Information and Decision Support System section

1. Would you use a computer-aided Information and Decision Support System (IDSS) and how could an IDSS help you?
2. How do you envisage a Graphical User Interface that supports you to develop planning alternatives?
3. Which planning alternatives would you like to analyse with the IDSS?
4. If you would not use an IDSS to who would you advise it?

Appendix B: List of interviewed people

NAME	COUNTRY	ORGANISATION	TYPE OF WORK
Felix Helmich	Netherlands	Province North Brabant	Water management planner
Paul van Dijk	Netherlands	Water Board Brabantse Delta	Policy maker
Mark van der Wouw	Netherlands	Water Board de Dommel	Intermediaire between policy makers and technicians
Albert Frielink	Netherlands	Water Board Aa and Maas	Policy advisor on water systems / project leader
Alan L. Hoekstra	Netherlands	Projectengineer, Ministry of Transport, Public Works and Water Management, Project Analysis Department	Urban planer
Werner Mennen and Luc de Leeuw	Belgium	Muese river basin / Demer river basin	Policy makers
Karin Karras	Germany	BfG	Consultant for decision makers / scientific assistant
Roland Boettcher	Germany	BCE Consulting	Consultant for decision makers
Wilhelm Augst and Michael Junk	Germany	Regional office for water and waste management and soil protection of the Planning and approval authority North (Struktur- und Genehmigungsdirektion (SGD) Nord)	Deciding authorities
Bernd Dewald	Germany	Water Board Bergstrasse	Director of the Water Board
Ortwin Gieseler	Germany	Regierungspräsidium Darmstadt / Abteilung Staatliches Umweltamt / Dezernat IV/Da 42.2 Oberflächengewässer	Deciding authority / control authority

Appendix C: Text of the Internal Workshop role plays

Case 1. Making of a plan in a low land brook catchment area

1 The plan

In the nineties there were 2 floodings in this region causing much problems to farmers and households in a town downstream of this brook. The plan wants to prevent this by new methods in the agricultural areas. But there are also a lot of woods in this region. The government want to use woods to store the water. A plan has to be made by a well known consultancy office which shall do this by order of the state government.

2. Situation

This is an area which is flat. The differences in height vary from 25m above see level up to see level. There are some polders in the lowest part which have a clay soil. The higher parts have a sandy soil and here the brook has his sources. These are mainly situated in the agricultural areas. The polders are mainly used as agricultural land. One side stream of the brook is embedded in a big nature reserve. Some of it is owned by nature conservative organizations. In this reserve some rare species live in the brook, which are on the EU habitat directive list. The area consists of 80 % agricultural land, 15 % of nature reserve and 5% is used for buildings and transport roads.

3. Alternatives

Some alternatives are proposed: Some people think of making storage reservoirs, other people are thinking of building dikes along the brook.

4. Scenarios

At present the calculations are done on rainfall of 40 mm in a 12 hour period.
The future scenarios (year 2050) are based on rainfall of 50 mm in a 12 hour period and the summer period is dryer in present times. This is caused by rising of the temperature by 3 degrees Celsius

5. Involved persons end roles:

Policymaker:

This person has to make the plan. He works at the ministry of Spatial Planning and rural development. He has experience in plan development on regional scale. He is a technician en has a scientific background on water management. This plan should be realized within one year. Inhabitants has to be consulted. He has already made a committee in which the government has invited the main communities, some NGO’s , the farmers and nature conservation organizations. Now he is at the point that he wants to discus the results of the calculations made by the consultants. There is also made a concept development plan. The hydrologic calculations have given a map showing regions where storage of water has to be realized.

Chief of the policymaker:

He is the leader of a group of policymakers and he has an intermediate role between the persons he is giving orders to and the chosen administrative persons, mostly politicians. He has a scientific juridical education. He wants to realize this plan in one year. He is not interested in hydrology, nature or ecology. He is more interested in political weighing of interests of certain groups in society like farmers, economists, traffic, etc.. He has good relations with the large communities in the area on the administrative level. When the plan is ready he has to make the final proposal to the governmental level in order to get the right decisions done. He stands for the upper level of the organization where he works for.

Wood manager:

This man is owner and is responsible for the maintenance of a great part of the woods. He has good relations with the nature conservation organizations and wants to keep it this way. There are problems with drought in the woods, but he is afraid that if there will be a higher groundwater level, many trees will die. Furthermore he thinks that the water quality is poor due to usage of artificial manure in the agricultural areas. Woods will be eutroficated. He is also afraid that certain nature values will be decreased when the plan is realized.

Farmer:

He has a great farm in the polders, where he grows potatoes and wheat. He is chairman of an organization of farmers in this region. The farmers don't want to lose any land, but are interested in green-blue services. There is no good relation between the nature conservatives and the farmers. They always discus about the usage of fertilizers and chemicals used in agriculture. There are also farmers in this area that have many cows and corn fields. There is to much manure produced in the area. Therefore a program is running to minimize this.

6. Task of this four people: Discus the development of the plan

Case 2. Making of a plan in a hilly region

1. The plan

In the nineties there were 2 floodings in this region causing much problems to farmers and households in a town downstream of the brook. The plan wants to prevent this by making a large water storage basin or some smaller storage basins. But as a large part of the brook is flowing through agricultural land a proposal was done to enlarge the bedding. A plan has to be made by a well known consultancy office who will do this by order of the local water board.

2. Situation

This is an area which is hilly. The differences in height varying from 500 m above see level up to 50 meter above see level. There are some swamps and much agricultural land as well in the lowest part which has a clay soil. The higher part has a rocky soil with clay on it and here the brook has his sources. Many side streams of the brook are found in a nature reserve. In this reserve some rare species live in the brook, which are on the EU habitat directive list. The area consists of 30 % agricultural land, 55 % of nature reserve and 15% is used for buildings and transport roads.

3. Alternatives

Some alternatives were proposed: Some inhabitants and administrative persons are thinking about assigning particular grounds where construction will be prohibited in future, others are thinking of diminishing the rainwater run off by catching this in small storage reservoirs in the rural areas and along the roads.

4. Scenarios

At present the calculations are done on rainfall of 40 mm in a 12 hour period.
The future scenarios (year 2050) are based on rainfall of 50 mm in a 12 hour period and the summer period is dryer in present times. This is caused by rising of the temperature by 3 degrees Celsius

5. Involved persons:

Policymaker:

This person has to make the plan. He works at the regional organized Water Board. He has experience in plan development on regional scale. He is a technician en has a scientific background on water management. This plan should be realized within one year. Inhabitants have to be consulted. He has already made a committee in which the Water Board has invited the main communities, some NGO's , the farmers and the nature conservation organizations. Now he is at the point that he wants to discus the results of the calculations made by the consultants. Also a concept development plan has been made. The hydrologic calculations resulted in a map showing regions where storage of water could be realized.

An administrative person chosen by the inhabitants in the city in the water board:

This person is chosen by the inhabitants in this region. He is a politician and member of a party that stands for the right wing in politics. So he became member of the Water Board administrative unit. His party is concerned about the future. The members of the party are mostly people which are in the upper level of the society like directors of industries, doctors, surgeons, dentists etc. He has a scientific background on philosophy. So he has no idea of water management, but wants that all inhabitants are living in a save world. The members of his party wants that their homes and their industrial constructions and buildings or plants are build on safe places.

Someone of the WWF:

He is an ecologist working for the World Wildlife Fund. He has many contacts with other nature conservation organizations and therefore he is chosen in the working committee. He wants that his alternative will be used and that other calculations will be used then the consultancy has done. So there is a need for a model study on the impact of the water storage basins. He is special concerned of the fish that is living in the brook and some rare species that are on the Habitat Directive list II and IV which are living in this catchment area is specific habitats. He proposes that it should be better to make small reservoirs in the towns to collect and store the rainwater. He has also the idea that the area which might be flooded should be free from buildings and constructions.

Town developer (architect):

This man works in one of the big cities in the catchment area. He has a civil engineering background. His work is making of development plans of the city. So he is concerned about safety of all the buildings in the towns and villages. He want to be sure that no floodings will take place in the old town centers. He thinks that by making good plans in the newly developed regions around the old towns, he can solve the problem of flooding. But there is not sufficient place to do this and his chief has told him to pay very much attention to this spatial planning problem and the costs which are related to solve this. The ground prices in the valley are extremely high, because it is easy to build there. He has to explain the plan to his chief but afterwards also to the mayor and the alderman of the city. He has to prepare how a decision can be made.

6. Task of this four people: Discus the development of the plan

Case 3. Realization of a project in a lowland region

1. The project

In the nineties there were 2 floodings in this region causing much problems to farmers and households in a town downstream of the brook. The project wants to prevent this by giving a new place to the old dyke and to realize more natural banks along the brook. This project has to be realized by the water board. A well known consultancy office which shall do this by order of the water board wants to make a development plan and has to consult the inhabitants before the water board can realize this project.

2. Situation

This is an area which is flat. The differences in height vary from 25m above see level up to see level. There are some polders in the lowest part which have a clay soil. There is also a 250 years old dyke. The higher parts have a sandy soil and here the brook has his sources. These are mainly situated in the agricultural areas. The polders are also mainly used as agricultural land. One side stream of the brook is embedded in a big nature reserve. In this reserve some rare species live in the brook, which are on the EU habitat directive list. At the place where the project will be developed some rare species live which are on the list of threatened species. The area consists of 80 % agricultural land, 15 % of nature reserve and 5% is used for buildings and transport roads.

3. Alternatives

Some alternatives were proposed: Some inhabitants and administrative persons are thinking about choosing preventive measures in the towns where new parts of the cities will be developed. So they think that for instance diminishing the rainwater run off by catching this in small storage reservoirs in the new builded areas or along the roads solves the problem.

4. Scenarios

At present the calculations are done on rainfall of 40 mm in a 12 hour period.
The future scenarios (year 2050) are based on rainfall of 50 mm in a 12 hour period and the summer period is dryer in present times. This is caused by rising of the temperature for 3 degrees Celsius

5. Involved persons:

Projectleader (technician):

This man is working at the local water board and his duty is to realize this project. He has a civil engineering background. This project should this be realized within three years. Inhabitants have to be consulted. He has already made a committee in which the Water Board has invited the main communities, some NGO's , the farmers and the nature conservation organizations. Now he is so far that he wants to discus the results of the calculations made by the consultants. There is also made a concept development plan. The hydrologic calculations have given a map on which the area is located where the best place is to replace the dyke and on what part the banks has to be developed in a more natural way.

Policy maker:

This person has to advice on this project. He works at the regional organized Water Board. He has experience in project development on regional scale. He is a technician en has a scientific background on juridical issues. This project should be realized within three years. Inhabitants has to be consulted. He has to present the plan to his chief in a way that decisions can be made and the money to realize the plan is put on the investment list of the water board. He is not very interested in nature or ecology but has heard that there are problems with a rare specie of insect along the banks of the brook.

Inhabitant:

This man or woman lives in the area where the new dike will come. The view on the landscape will change very much and they don't like this at all. He / she thinks that there are good alternatives. She/he proposes that new calculations are made in which more local reservoirs in the new build areas of the city where here family is living can solve the problems of flooding. She/he thinks that the EG WFD is not properly used to make this project. She/he also is a member of the local political party which is of the right wing in politics. She/he mostly reads Reader Digest and the local paper, she/he looks never to the television, but listens to the radio. She/he has to explain this project in the meeting which will be organized next week. Then she/he has to make a presentation on it. She/he is searching for help. She/he knows that her neighbors don't want the dyke in their gardens.

NGO (biologist, ecologist):

He is an ecologist working for the local World Wildlife Fund. He has many contacts with other nature conservation organizations and is in that way chosen in the working committee. He wants that alternative calculations are made to be sure that calculations that the consultancy has proposed are correctly done. He says the there is a need for a model study on the impact of the small water reservoirs in the towns. He is special concerned on the fish that is living in the brook and some rare species that are on the Habitat Directive list II and IV that live in this catchment area is specific habitats.

6. Task of this four people: Discus the development of the project

<u>Case 4. Realizing of a project in a hilly region</u>

1. The project

In the nineties there were 2 floodings in this region causing much problems to farmers and households in a town downstream of the brook. The project wants to prevent this by giving a more space to the brook and also to make a water reservoir somewhere upstream. This project has to be realized by the community which is laying near the end of the brook. A well known consultancy office has got an order of the water board to make a development plan and has to consult the inhabitants before the water board can realize this project.

2. Situation

This is an area which is hilly. The differences in height varying from 500 m above see level up to 50 meter above see level. There are some swamps and much agricultural land as well in the lowest part which have a clay soil. The higher parts have a rocky soil with clay on it and here the brook has his sources. Many side streams of the brook are found in a nature reserves. In this reserves some rare species live in the brook, which are on the EU habitat directive list. In the area where the reservoir is to made some rare species live, which are on the EU habitat list as well. The catchment area consists of 30 % agricultural land, 55 % of nature reserve and 15% is used for buildings and transport roads.

3. Alternatives

Some alternatives were proposed. Some inhabitants and ecologists propose that restoration of the brook might help more than this project can help to prevent flooding. They say also that alternative new agricultural methods can help to solve the problem.

4. Scenarios

At present the calculations are done on rainfall of 40 mm in a 12 hour period.
The future scenarios (year 2050) are based on rainfall of 50 mm in a 12 hour period and the summer period is dryer in present times. This is caused by rising of the temperature for 3 degrees Celsius

5. Involved persons:

Projectleader (technician):

This man is working at the local water board and his duty is to realize this project. He has a civil engineering background. This project should be realized within three years. Inhabitants has to be consulted. He has already made a committee in which the Water

Board has invited the main communities, some NGO's , the farmers and the nature conservation organizations. Now he is so far that he wants to discus the results of the calculations made by the consultants. There is also made a concept development plan. The hydrologic calculations have given a map on which the area is located where the best place is to realize his project. Also is known which parts of the brook are to be broadened and where the banks can be developed in a more natural way.

Policy maker:

This person has to advice on this project. He works at the regional organized Water Board. He has experience in project development on regional scale. He is a not a technician en has a scientific background on social issues. This project should be realized within three years. Inhabitants has to be consulted. He has to present the plan to his chief in a way that decisions can be made and the money to realize the plan is put on the investment list of the water board. He is not very interested in nature or ecology but has heard the there are problems with a rare specie of a plant which is occurring along the banks of the brook. This plant is protected by the Habitat Directive.

Inhabitant:

This man or woman lives in the area where the brook will be broadened. He/she has to give up a piece of land. The view on the landscape will change very much and he/she doesn't like this at all. She thinks that there are good alternatives. She/he proposes that new calculations are to be made in which results are presented about a brook which is highly modified to a more natural state. This should help to solve the problems of flooding. She/he thinks that the EG Habitat directive is not properly used to make this project. She/he also is a member of the local political party which is of the left wing in politics. She/he mostly reads Nature and the local paper, she/he looks very much to Discovery Channel on television, and listen to the local radio. She/he has to explain this project in the meeting which will be organized next month. Then she/he has to make a presentation on it. She/he knows that her neighbors don't want the project of the water board in their gardens.

NGO (ornithologist, ecologist):

He is an ecologist, ornithologist working for the local Nature society. He has many contacts with other nature conservation organizations and is in that way chosen in the working committee. He wants that alternative calculations are made to be sure that calculations that the consultancy has proposed are correctly done. He says that there is a need for a model study on the impact of the project. He is special concerned on the fish that is living in the brook and some other rare species of plants that are on the Habitat Directive list II and IV that live in this catchment area in specific habitats.

6. Task of this four people: Discus the development of the project.

Appendix D: Tables with distilled requirements and objectives

nofdp Project Partners Developments

COMMUNICATION-nofdp PROJECT DEVELOPMENTS	***Key concepts***
transparency	transparency
not only model results	
results understandable and simple	
not too detailed and single processes but giving commonly accepted interrelations in the system river	not too detailed system analysis
serve general topics and to be adapted to particularities (if possible)	
widely understandable platform	interface between different kind of knowledge
lists with easy understandable context between soil, water, fauna, flora	
many different tools for different experts	
external consultants for the application of models	
make consequences visible	visualise consequences
people must be able to see where the effects are located	
to show consequence of high water with people which are not familiar with	
effect of a 10,20,50, annual flood event	
give information on the fact that a land is inundated more than once in ten years, linked to buy land for enhancing nature	
to show why some area can be used for water storage and others no	
to show that it will be no problems with sewage pipes during high water periods	
show if with alternatives there is the possibility of fishing (also in the ponds)	
to show how a destination plan (functions of spatial usage) of a village can change	
mapping functions	preference for maps
output as table, maps and graphs	
indicators to make consequences clear to non experts	indicators
harmonizing interests of stakeholders and authorities in the decision process	harmonize conflicts
tools to address and evaluate all stakeholders issues	
multi-sectoral as well as a multi-objective planning approach	
help in case of expropriation conflicts	
to convince farmers, giving facts on n-year flooding and water quality (accumulation of pollutions)	
gaining public acceptance	
discussion support system	IDSS should support the discussion phase of the DMP
support tool for discussion with public and decision makers	
support the opening planning process	
consultants directly use the DSS decision makers accept it in discussion	
DSS used in external meetings with authorities and stakeholders	
improving public participation	public participation
high degree of public participation	
convince local population of the merit of improvement of spatial flood storage and ecological state	

with the public important questions are: why a measure/their benefit/ why the need of restricted areas	
convince people and authority of following the right directive (FFH)	
convince people not building in flood plains	
provide information whether the ecologic condition of a water body is improved by realising a particular measure	
SYNTHESIS	
R: The IDSS end user should always have the possibility to understand how and where the outputs of the model base are generated when not enough the system has to be spilt in many parts O: Provide the user with as much transparency as possible avoiding a black box system	
R: The IDSS should be equipped of representation instruments (maps, graphs, tables, indicators, etc.) O: Try to represent the model output and make it more comprehensible in particular for the public	
R: The IDSS should provide information in a balanced multi-sectoral point of view O: Harmonize the conflicts of interest that could arise during the planning process	
R: The IDSS should support the discussion phase of the DMP O: Use the IDSS in meetings where decision makers and consultants have to discuss different alternatives with the stakeholders involved	
R: The IDSS should underline the benefits linked with nature oriented flood damage prevention alternatives O: Improve public participation and acceptance in the planning process	

MODEL CALCULATION-nofdp PROJECT DEVELOPMENTS	***Key concepts***
input of existing data like land use, agriculture, urban use (database)	input of existing data
economic value of land	
land property	
categorisation of land use types	
quality of sludge	
work with different type of morphology of catchments	
storage of data	storage of data
proposals are made by stakeholders	also consider proposals made by stakeholders
uncontrolled flood-control retention areas	flood damage prevention measures
flood-control retention basins	
reclamation from retention areas	
controlled flood-control retention basins	
construction of dykes/banks	
relocation of dykes/banks	
Increased width of drainage channels	
consider storage in the upper course where floods are generated	
protection of area with archaeological, historical, agricultural, ecological high value with small dyke or drainage	
preservation of free areas as flood plains and verification of their legal status	nature-oriented flood damage prevention measures
returning bodies of water to their natural state	
consider scenario like dykes removal and restoration of floodplains	

other scenarios like re-allotments and reconstruction of rural area	
meanders restoration	
consider that the brook can become an ecological connection zone	
green-blue corridor connecting small and large natural areas	
ecological forest development	
increasing the ecological value meandering the river and flooding the woods	
the alternative of wet riparian zones (help to reduce the entry of nutrients, but it doesn't work for heavy metals)	
improve natural riverbanks with reed, groves, floodplain grasslands and marsh vegetation	
development of water storage, swamplands, ecological embankments, riparian forest and recreational facilities.	
change of the landscape	
consider changes in the land use	
supporting decision making for multiple land use	
habitat appropriate land use	
consider densely populated low-land river regions	Scenario
deal with peak discharge and dry periods	
scenario like rising of see water level	
dying of fishes during low flow in summer	
NWE-region dimension	transnational dimension
transnational dimension / cooperation	
water body as reference	
regional scale	
management plans catchment level	
catchment wide integrated planning methodologies	
structured scaling from coarse to fine	
modelling on local and river scale	
entire catchment=low resolution scale/project level=high resolution scale+intermedium scale?	
catchment scale(flood protection and ecology)+combined scale(identify optimum site)+measure scale(optimise single site) keep in mind changing slope and distance to the see (to keep or to discharge!!!!!!)	
local scale=effect of a measure on vegetation+effect of catchment wide scenario on functionality/regional scale=development of master plan (scenario based)	
scales have to be determined according to data availability	
temporal resolution low on regional level / high on local scale	temporal scale
temporal scale short term= single event+long term=lifetime of measure	
assess the role and effect of small to medium scale measures	integrated forecasting/assessing the status of the three layers
forecasting the impacts of planning scenarios on components of the riverine system	
assessing the possible future status of the three layers (water,human,ecology level)	
components hydrology, hydrodynamic, ecology, water quality, phisic(flow speed)	
consider problems linked with water quality and the fact of using floodplains for agriculture (link floodplain and water quality)	
groundwater and sedimentation process have to be added	
make groundwater calculations in high water periods for buildings of villages	
potential damage to nature	
forecast the impact on ecology	
the models have to consider the effect of changing hydrological conditions on the development of ecological status	
coupling of hydraulic/hydrologic-ecologic models (eco-hydrological software) to evaluate ecological effects of flood prevention scenarios	

number of species is a good indicator for ecology, it have to be in the ecological models	
modelling of vegetation	
water quality parameters during floods for woods	
frequency of flooding	flood risk/flood frequency
flood risk	
flood protection target 1/50 years and 1/100 years for urban areas	
flood prevention objective for water board 50 years	
forecast (uncertainty)	uncertainty
level of uncertainty	
to have a very detailed description of uncertainties in the respective indicators	
no demand for real time control	technical requirements
a model and internet based DSS to optimise flood damage with respect to the ecosystem functionality	
open interface structure of the model-base (the user can plug in his models)	
communicating with GIS	
models widely used	
open source models	
coupling of models	
SYNTHESIS	
R: Input and storage of a great amount of existing data O: Handle the integrated view of nofdp	
R: The input of model calculations is a large variety of nature oriented flood damage prevention measures, variants and scenarios regarding small and medium size river basins; some more technical measures have also to be integrated O: Evaluate proposals coming from the users of the system	
R: Flexibility in scales resolution: river basin level=low ressolution+measure level=high resolution O: Low resolution for global planning, assessing effects of flood damage prevention measures upstream and downstream, no political boundaries (see EU WFD) and high resolution, for local effects of measures on vegetation and ecology	
R: A good integrated model base or integrated post evaluation of single models outputs O: Forecast the future status of the three layers (water, human, ecology)	
R: Flood risk and flood frequency O: Integrate water board flood prevention targets	
R: Indication of uncertainty in models calculations O: Evaluate the reliability of models results	
R: The IDSS model base should contain open source, widely used, coupled models with an open interface structure (no demand for real time), essential is the link with the GIS O: Wider distribution of the IDSS	

TOOLBOX-nofdp PROJECT DEVELOPMENTS	***Key concepts***
checklist functionality	general reduction of complex information through check lists and guidelines
reduction of the complexity of the information and representation of them	
formulation of guidelines	
providing relevant information on Eu and national laws	schematisation of

	directives, laws, methodologies, general nature-oriented policies
prevent potential violation of EU WFD and to comply with other EU directives	
deal with habitat directive in integral projects	
consider special and protected species/biotopes of flora and fauna (Habitat directive)	
consideration of bird and ecological important groups in the catchment area (FFH)	
interface with environmental effect report (MER)	
interface with structure like Ecological Connection Zones	
compilation of relevant spatial planning methodologies and instruments	
formulation of priorities/preferences in case of a list of measures that have to be realised successively	
giving examples of nature-oriented flood damage prevention (Knowledge base?)	best practice examples
generation and representation of new information	generation of new information by overlapping them
DSS=aggregation of existing data results on local/regional level	
combining visions of farmers, environmental and conservation organisations, people, water boards, municipality	
to show the differences in variants, effects on nature, agriculture, urban area not only with maps	
land vulnerability	
indicate pressure on the water bodies	
SYNTHESIS	
R: The IDSS should provide the user with a selection of most relevant information regarding nature oriented flood damage prevention alternatives O: Reduce the complexity of a great amount of knowledge	
R: Generation of new information by overlapping them on the local and regional level O: Put together different visions of the problem and show the effects of this overlap	

EVALUATION-nofdp PROJECT DEVELOPMENTS	***Key concepts***
compare planning alternatives	compare, weigh, evaluate
weigh various conflicts of interests	
multi sectoral and multi objective evaluation scheme for model based predictions	
target values must be defined, assessed and evaluated taking into consideration the objectives “ecological damage”, “flood damage” and “spatial development”	
evaluation scheme that uses criteria like legal protection status of biotope types, Red List criteria, rareness, restorability, etc.	
good placing for floodplains	
priority list of potential retention basins	
assets and drawbacks of river as a recreation area	
emotional values?	
testing objectives	
reference situation	testing objectives
to consider situations where it exists no alternative, but only an evaluation of effects is requested...	
making optimum decisions for riverine flood damage prevention planning	optimisation
find the best location for water retention areas	

multi-criteria analysis function	
economy and socio economic should be included in the evaluation system and not in the modelling part	
monetary benefits of ecological systems (the fact that a more natural space signify more retention volume)	economical benefit of nofdp
calculations on compensation payments, in particular regarding green-blue services	compensation payment
economical aspects of EU WFD	
SYNTHESIS	
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare different planning alternatives and weigh different interests arising from the integrated planning approach	
R: Optimisation function O: Make optimum decisions	
R: Assess the monetary benefits of nature oriented flood damage prevention and monetary compensations for the inundated land O: Give a monetary value to nofdp, underlining the monetary benefits and calculating the costs	

Potential Users Interviews

COMMUNICATION-POTENTIAL USERS INTERVIEWS	***Key concepts***
transparency	transparency
It should be possible to have insight in the parameters used	
valuation by common accepted standards, transparent	
symbols	symbols
using symbols on maps	
help in the lack of a common language	glossary function
glossary function	
two IDSS systems (sustainable for technicians-visualisation of problems (used by policy makers, administration))	split the system
some model calculations are done internally others externally	
external consultants doing the model calculations	
simple and self explaining	self explaining/easy to use
small, simple and self-explanatory	
toolkit for polders, setting back of dikes etc.	
possibility to enter subjects of protection (‘Schutzgüter’, like flora, fauna, soil, water, FFH, Ramsar, WFD)	
to prepare the right decision which has to be made by government (using the right information)	help in preparing the vision on which the administrative level has to make the decision
prepare the vision which need to be decided upon by consulting the inhabitants. The final decision is made by the minister himself.	
help in the preparation phase for a concept plan	
intermediate between policy maker and technicians (special for the Water Board Dommel)	
cooperate in the iterative process between officers and administrative level	
iterative process (finding optimum solution/model calculation-communication-look at alternatives)	
IDSS = argumentation Help	
rather for the client not for the consultancy office	
consultant for communities and cities	harmonize conflicts and be informative, in particular for stakeholders
to inform citizens	
solve conflicts by making the plan in an iterative way talking with involved people	
make clear what are the conflicts and discussing them with people involved	
contrast arises with people living in the investment area they fear changes, less problems are with nature related NGOs	
especially for a (purposely) overemphasised presentation of hard conflicts	
help in the acceptance of the other parties	
Interaction=improving the discussion	
deal with conflicts in spatial planning field	
to show the effects of a measure	visualisation of results
how alternative xx yy will look like	

visualise how floodings will take place and how	
show the all water levels not only three or four selected levels	
good picture of the vegetation, vegetation change over time – see vegetation grow,	
standardised system for all in order to compare the projects and to avoid different styles of presentation	
visualisations or simple tables	
less tables	
aerial photos (as a background)	
SYNTHESIS	
R: The user should have the possibility to understand the output of the IDSS (e.g. symbols on maps, glossary functions etc.) and how it is generated (no black box system) when not enough the system has to be spilt up in many parts / different user interfaces for different users (in particular most of the time the model base will be operated by external consultants) O: Provide the user with as much transparency as possible and improve the mutual understanding in an inhomogeneous group of experts	
R: The user interface of the IDSS should be self explaining O: Provide the user with as much user-friendliness as possible	
R: The IDSS should support the user in preparing concept plans for the administrative level O: Be an intermediary in the iterative and interactive process between the technical and the administrative level	
R: the IDSS should present its information in a comprehensible and balanced way O: Inform citizens and communities in order to solve conflicts arising in the planning process (in particular regarding the spatial planning)	
R: The IDSS should be equipped of visualisation instruments (visualisations, pictures, aerial photos etc.) O: Visualize the model output and make it more comprehensible	

MODEL CALCULATION-POTENTIAL USERS INTERVIEWS	***Key concepts***
input of existing data	input of existing data
using an DSS called Ecovise link to IDSS	
linking IDSS with Retentionskataster and Retention Storage Plans	
land use is an important item	
consider protected nature areas	
proposals arise frequently from the needs of the communities	also consider proposals made by stakeholders and decision makers
most likely alternatives to decision makers	
polder	flood damage prevention measures
river bed lengthening	
drainage removal	
solving local problems by means of regional measures	
alternative of realising flood damage prevention only by means of little measures	nature-oriented flood damage prevention measures
additional measures as alternative (e.g. mobile walls)	
environmental alternatives	
naturalistic engineering	

various others, natural techniques and material preferred	
unused banks with free vegetation succession	
bank plantations	
renaturation	
alternative of paying for the damages caused by floodings	other alternatives and scenarios
alternative is the autonomous development of the region: development in land use, plans of the cities, MES, development in brook restoration, not connecting the brook to sewage system	
variant 1: maximum usage of the natural possibilities	
variant 2: maximum usage of the water storage basins	
15% more in discharge peak like alternative	
for spatial planning only scenarios 10 years ahead	
future scenario (2050) WB21	
future scenario (2015,2020,2050)	
regional scale	scale resolution
have a regional knowledge	
water system level/project level	
project on local scale, plans on larger scale	
regional scale for plans, smaller scales for projects	
larger scale as the project scale in order to have no problems out of the project	
attention should be paid to the processes that influence the process: groundwater, nature, ecology etc.	integrated forecasting/assessing the status of the three layers
risk potentials, including an integration of ecological and economical issues	
50 years flood risk	flood risk and inundation volumes
volume in case of floodings	
volume of potential retention areas	
link with GIS	technical requirements
GIS for the spatial information	
SYNTHESIS	
R: Input of a great amount of existing data and possible link with other interesting data base(e.g. Retentionskataster,nature protected areas etc.) O: Handle the integrated view of nofdp	
R:The input of model calculations is a large variety of nature-oriented flood damage prevention measures, variants and scenario some more technical measures have also to be integrated O: Evaluate proposals coming from the user of the system	
R: Flexibility in scales resolution: project level=local scale and plan level=regional scale O:Consider in particular a larger scale as the project scale in order to have no problems out of the area affected by the project	
R: A good integrated model base or integrated post evaluation of single models outputs O: Forecast the future status of the three layers (water, human, ecology)	
R: Flood risk and calculations on volumes in case of floodings and with retention areas O: It's a natural requirement of flood prevention	
R:The IDSS should be linked with GIS O: Good management of spatial information	

TOOLBOX-POTENTIAL USERS INTERVIEWS	*Key concepts*
EIA criteria (check list)	general reduction of complex information through check lists and guidelines
guidelines of the states spatial planning authorities	
structuring the planning process, help not to forget something (check list)	
River system status check in case of a drought period (link flood with drought management)	
model base provide basic information for later visualisations	
identification and localisation of conflicts	localisation of conflicts
abandoned polluted areas (Dangers in case of flooding)	
risk potentials including ecological + economical issues (risk maps)	
compromise sketch (e.g. test the alternative to put nature over there and see how it would look like)	compromise sketch
maps with different layers	
GIS overlays	
SYNTHESIS	
R: Reduce information in form of thematical check lists and guidelines O: Supporting the user reducing a great deal of information	
R: Generation of new information by overlapping them for example in form of maps with different layers O: Identify and localise conflicts (e.g. dangers in case of flooding of abandoned polluted areas) or visualize new alternatives	

EVALUATION-POTENTIAL USERS INTERVIEWS	*Key concepts*
weighting interests to solve conflicts	weight
deal with conflicts on spatial planning, water quantity, ecological targets, economy (costs and benefits).	
weigh the interests of farming, nature, recreation, economy, shipping, energy, water supply, drinking water and so on	
A compromise is wanted weighting natural development and safety aspects (ex. Natural elements, such as vegetation, increases bed roughness and therefore lowers the level of safety of neighbouring dykes)	
minor problems arise with ecological issues	ecology minor problem
Big problems between spatial planning and flood prevention	spatial planning big problem
weighting alternative solutions	
weighting alternatives	
polder optimisation regarding ecological value	optimisation
Polder optimisation	
cost of measures	costs of measures
answer to questions like feasibility of a measure also as far as costs are concerned	
cost/benefit concerning several small or one large measure	
compensation payment	compensation payments
damage to farmers	

debasement of floodplains	
e(valuation tool) ranking	alternatives classification
grouping/categorizing alternatives	
alternative classification(economical the best-nature friendly-optimal solution(water level))	
alternative classification (maximum usage of natural possibilities-maximum usage of water storage basins)	
alternative classification (refer to milieu effect rapporten)	
alternative classification-zero variant	
Complete abandonment of utilisation as reference point	
Status quo as a reference point	
status quo as a reference point	
SYNTHESIS	
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare different planning alternatives and weigh different interests, more attention has to be posed on spatial planning conflicts as on ecology	
R: Optimisation function O: Make optimum decisions in flood damage prevention planning	
R: Assess the monetary aspects of prevention of flood events (ex. costs of measures and compensation payments) O: Introduce the monetary aspect in the evaluation process (give monetary value to nofdp)	
R: Systematisation of alternatives by means of classification O: Categorize, group and rank alternatives	

International Workshop Role Plays

COMMUNICATION-INTERNAL WORKSHOP ROLE PLAYS	*Key concepts*
transparency demand	transparency
transparency of model and planning results (how much is wanted, is possible?)	
give proposals to general answer and not too specific questions	not too detailed system analysis
overall approach but also some constraints (particularities of projects) -> general topics and specific topics, IDSS can only serve for general topics and must be adapted to particularities (if possible)	
IDSS GUI to the public / to the planner / to the policy maker	split the user interface
stakeholders asked why there must be a measure in their backyard and not somewhere else, this highlights the need for information and good calculations to know exact what area is effected and why this area is needed. But calculations only are not enough, background information is wanted.	visualisation/presentation
show why the problem can not be solved somewhere else	
Need for clear basic presentation material (maps, data etc.) related to topic and solution to be achieved	
great need for visualisation, the most frequent question is where!!!	
policy maker need a map showing where storage of water has to be realized	
wood manager wants to see where flooding areas are located	
farmer want to visualize flooding areas	
need to visualise the effects of variants and measures related to topic and solution to be achieved using clear presentation material (maps, data, tables, etc.)	
farmer want to visualize the effects	
policy maker has to prepare the concept plan for the administrative level	help in preparing the vision on which the administrative level has to make the decision
inhabitants have to be consulted	information for inhabitants
policy maker needs to communicate with inhabitants, communities, NGO's , farmers and nature conservation organizations	
The DSS can be used in external meetings with authorities and stakeholders	IDSS should support the discussion phase of the DMP
policy maker want to discuss the result of model calculations	
DSS will not directly be used by decision makers or project leaders. Consultants will set up and operate the DSS. But decision makers will accept using a DSS in discussions.	
common language	common language
lack of common language	
Communication is the big challenge	
more information regarding competences not included in the personal knowledge is needed (e.g. difficulties in the interpretation of hydrologic results)	
need for a common language between stakeholders	
the administrative level don't understand hydrological calculations	
policy maker have to make an evaluation about something not included in his field of competence	
SYNTHESIS	
R: The end user should have the possibility to understand the outputs of the model base, a too detailed system diagram is to be avoided, when not enough the system has to be spilt in many parts / different user interfaces for different users O: Avoid a black box system and try to provide the user with as much transparency as possible	
R: The IDSS should be equipped of visualisation instruments (maps etc.) O: Try to visualize the model output in order to answer to questions like what for areas	

are interested, what are the effects and why not somewhere else	
R: The IDSS should help the user in preparing concept plans, that is to say prepare some of the information on which the administrative level has to make a decision O: Be an intermediary in the iterative process between the technical and the administrative level	
R: the IDSS should present its information in a comprehensible and balanced way O: Inform citizens and communities and the large amount of stakeholders involved	
R: The IDSS should support the discussion phase of the DMP O: Use the IDSS in meetings where decision makers and their consultants have to discuss on different alternatives with the stakeholders involved	
R:The system itself should act like a bridge between different type of knowledge O:Try to compensate to the lack of common language existing between an inhomogeneous group of experts	

MODEL CALCULATION-INTERNAL WORKSHOP ROLE PLAYS	*Key concepts*
the discussion included a lot of talking and promises. A good data and information base is needed.	input of existing data and information
land use is an important item	
spatial use in construction area clearly illustrated	
groundwater data	
need for GIS information	
alternative of storage reservoirs or building dikes along the brook	flood damage prevention measures
alternative between a large water storage basin or some smaller storage basins	
alternative of storage in the upper part to defence the lower part	
make dyke higher	
alternative between a large water storage basin or some smaller storage basins	
keep, store, discharge water policy	nature-oriented flood damage prevention measures
keep the value of nature	
lower the dykes	
greater storage room lower dykes	
alternative of storing water in the woods	
water continuity for fishes	
present scenario 40mm 12h period	Scenario
scenario 2050 50mm 12h period	
consideration of future scenario (e.g. global change)	
transnational problems, because waters flows between two countries	focus on river basin for scale resolution
policy maker needs to develop plan on a regional scale	
see if a solution is good for a city, but also for other cities	
to consider the whole catchment, no local solution	
most important is to show the differences in variants. What are the effects on nature, agricultural and urban area (list to be extended).	integrated forecasting/assessing the status of the three layers
appropriate hydrological result that serves the ecologist	
What is the effect of a 10, 20, 50, etc. annual flood event?	calculations on different flood events
flood target for cities 50 years, for agricultural areas 10 years	

risk assessment of planning alternatives	
forecast uncertainty is absolutely needed for the evaluation of alternative variants	level of uncertainty
What is the level of uncertainty?	
GIS based	link with GIS
make calculations again, act in the iterative process with little time (to spare time)	spare time in the iterative planning process
spare time in the planning process and express the wish to advance the iterative process (discussion phase)	
calculate alternatives some other place along the brook	
need alternative calculations to be sure that calculations made by consultancy office are right	
spare time in the planning process and express the wish to advance the iterative process (discussion phase)	
SYNTHESIS	
R: Input of a great amount of existing data, a good data and information base is requested (in particular GIS data!)	
O: Handle with the integrated view of nofdp	
R: Possible input of a large amount of measures, variants and scenarios (particular attention has to be posed on nature oriented alternatives)	
O: Evaluate proposals coming from the users of the DSS and the stakeholders involved	
R: Flexibility in scales resolution: the attention was posed on transnational level and catchment scale	
O: Consider a larger scale as the project scale in order to have no problems with other cities out of the project area	
R: A good integrated model base or integrated post evaluation of single models outputs	
O: Forecast the future status of the three layers (water, human, ecology)	
R: Flood risk and calculation on different flood events	
O: It's a natural requirement of flood prevention	
R: Indication of uncertainty in models calculations	
O: Evaluate the reliability of models results	
R:Technical requirement for the IDSS should be the link with GIS	
O: Good management of spatial information	
R: The system should have the possibility to make calculation again and present them in little time	
O: Spare time in the iterative process occurring in the planning process	

TOOLBOX-INTERNAL WORKSHOP ROLE PLAYS	***Key concepts***
consider nature reserves, which are on the EU habitat directive list	consider rare species, spatial restriction etc.
consider rare species in EU Habitat Directive	
clear definition of pre-conditions and spatial restrictions (e.g. due to legislation, natural design)	
present land use situation/restricted areas (legislative reasons)	
consider old centres	
consider the development plan	
confront the calculation on inundated land with land use	overlap of information
more information in form of overlapping maps	
identify and localize conflicts	localize conflicts

location of affected areas	
spatial planning is most important (spatial potentials and restrictions) => need to identify and localize conflicts (integrative view!)	spatia potentials
spatial identification of areas suitable for specific use	
clear identification of spatial potentials (areas available and suitable for use in various sectors)	
definition of sensible areas unsuitable for planning	
forecast location of flooded areas unsuitable for urban development	
SYNTHESIS	
R: Reduce information in form of thematical check lists and guidelines	
O: Support the user reducing a great deal of information he has to deal with in particular concerning legal restrictions	
R: Generation of new information by overlapping them for example in form of maps	
O: Identify and localise conflicts, affected areas and above all spatial potentials (areas suitable for a certain kind of use)	

EVALUATION-INTERNAL WORKSHOP ROLE PLAYS	***Key concepts***
variantmanager=Comparison and analysis of variants	Comparison/evaluation of variants
balanced and well argued evaluation of predictions, legal restrictions and planning for common solutions	
integrate many single objective points of view	
the main conflicts arise in spatial planning field	the attention is to pose on spatial planning contrasts
the administrative level has less interest in hydrology, nature or ecology, but more in political weighing of interests of certain groups in society like farmers, economists, traffic, etc..	
problems arise with the visual impact of a measure	visual impact
devaluation of Houses/landscape view problems	
landscape value is a good ecological indicator understood by all actors. Ecology gets important at a later planning stage. Actors are less interested in ecology except if ecology is helpful. Another indicator somehow related to ecology is recreational value.	
loss of life quality for inhabitants	
consider the recreational value	recreational value
ecology gets importance in a later state	ecology not so important in a early stage
in a early stage the role of ecology is not so important	
no real interest for ecology, but for example for rare species protected by the EU Habitat directive	
at an early stage ecology seems less important	
ecology apparently bears little conflict potential in nofdp. Ecological development supports flood damage prevention and shall be further improved. There are conflicts and opportunities	
cost benefit analyse	cost/benefit analyse
costs, because of fixed political budget	
present and future costs of planning alternatives	costs of measures
costs for land use change	cost of land use change
financial information is essential (restricted areas loose its value!)	
important item is the land value	
farmers do not want to loose land, but are interested in green-blue services	compensation payment

farmers want to keep the income for agriculture constant	
farmers accept flooding possibility, but want to know how much they are paid	
compensation/loss of production	
consider rare species in the woods and give a monetary value to them	
SYNTHESIS	
R: Multi sectoral and multi objective evaluation scheme with definition of target values for model based predictions O: Compare and weigh and show why an alternative; more attention has to be posed on spatial planning as on ecology! ecology=visual impact, landscape value, recreational value, eutrofication problems…it get importance in a later stage!	
R: Assess the monetary aspect of prevetion flood events (ex. costs of measures and compensation payment in particular for farmers) O: Introduce the monetary aspect in the evaluation process (give monetary value to nofdp)	

Appendix E: Questionnaire and results of the Interview with Ing. Matthias Sottong working at water board Mümling

Darmstadt, 21 July 2005

1. *Name, Organisation and Profession*

   Ing. Matthias Sottong working at the water board Mümling

2. *Could you please give priorities, to the following functionalities and requirements deriving from the conceptual scheme for the nofdp IDSS:*

++ Very important
+ Important
0 Equal
- Not important